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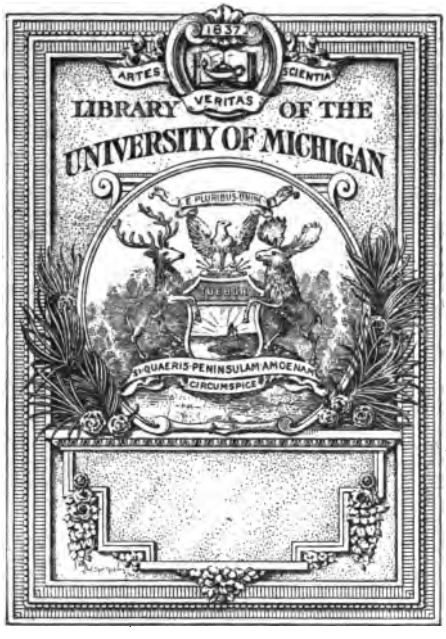
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ASSOCIATIONS

OF

GAS ENGINEERS AND MANAGERS

—UNITED KINGDOM—

ASSOCIATIONS

OF

GAS ENGINEERS AND MANAGERS

—UNITED KINGDOM—

REPORTS OF PROCEEDINGS

DURING

1899

OF THE

Eastern Counties Gas Managers' Association,
Manchester District Institution of Gas Engineers,
Midland Association of Gas Managers,
North British Association of Gas Managers,
North of England Gas Managers' Association,
North of Ireland Association of Gas Managers,
Scottish Gas Managers in Glasgow,
Southern District Association of Gas Engineers and Managers,
AND
Waverley Association of Gas Managers.

London:
WALTER KING,
OFFICE OF THE "JOURNAL OF GAS LIGHTING," ETC.,
11, BOLT COURT, FLEET STREET, E.C.

1900.

PRINTED BY
KING, SELL, AND RAILTON, LTD.,
12, GOUGH SQUARE, AND 4, BOLT COURT,
FLEET STREET, E.C.

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REPORTS OF PROCEEDINGS.

ASSOCIATIONS OF

GAS ENGINEERS AND MANAGERS

—UNITED KINGDOM—

1899

SOUTHERN ASSOCIATION.

ANNUAL MEETING, FEB. 9.

This Meeting was held at the Holborn Restaurant.

The proceedings were opened by

Mr. R. BEYNON (Torquay), the retiring President, who said his first, and only, duty was a pleasant one. It was to introduce the new President, Mr. A. E. Broadberry, of Tottenham, who, he sincerely believed, would conduct the affairs of the Association to their entire satisfaction.

Mr. BROADBERRY, on taking the chair, was received with hearty applause.

CONFIRMATION OF MINUTES.

The minutes of the last meeting having been taken as read, they were confirmed.

ANNUAL REPORT OF THE COMMITTEE.

The HON. SECRETARY (Mr. J. W. Helps, of Croydon) read the annual report of the Committee. They expressed their pleasure in recording that, under the presidency of Mr. Beynon, the membership of the Association had slightly increased, and that the character of the work had been successfully maintained. The Association had lost two members by resignation, four names had been removed, and two most valued members had been taken away by death. One of these (Mr. John Methven) was an old member of the Southern Association, and its President in

1891; the other was Mr. Joseph Phelps, a member of the South-Western Association. Ten new members had been admitted; making the total at the end of the year 155. The finances of the Association denoted a prosperous state of affairs; the balance carried forward being £92 6s. 11d.

On the motion of Mr. G. I. GOUGH (Calne), seconded by Mr. T. PRICE (Walton-on-Thames), the report was adopted.

THANKS TO THE EX-PRESIDENT.

The PRESIDENT then proposed that a hearty vote of thanks be accorded to Mr. Beynon for his services during the past year.

Mr. J. L. CHAPMAN (Harrow) seconded the motion, which was cordially agreed to.

Mr. BEYNON, in responding, said it had given him much pleasure during his term of office to attend the ordinary meetings, as well as those of the Committee. To him it was a most interesting feature of the Association, that the Committee meetings were so well attended. It was certainly worth the attention of the members to put forward their energies by reading papers and taking part in the proceedings, in order to entitle them to become members of the Committee.

NEW MEMBERS.

The HON. SECRETARY read the following nominations for membership: Mr. J. S. Ashworth, of the Portsea Island Gas Company, Mr. Archibald Caddick, of Croydon, and Mr. B. Bark, of Godalming.

Mr. H. H. JONES (Wandsworth) proposed that these gentlemen be admitted members of the Association.

Mr. T. PRICE seconded the motion, which was passed.

THE STANDARDIZING OF METER-UNIONS.

The HON. SECRETARY read the circular letter, which, under date of Oct. 10, 1898, was addressed to the District Associations by the Secretary of the Incorporated Gas Institute (Mr. Walter T. Dunn), and in which it was stated that the Council of that body considered it desirable that an application should be made to the Board of Trade with the object of obtaining their recognition of a set of standards for meter-unions in the United Kingdom; but that, before any action was taken, a circular should be issued to kindred Institutions and Associations, asking for their views and co-operation in the matter.

The PRESIDENT remarked that, when considering the letter which had been read, the Committee felt that the matter was not a very pressing one, and that it was advisable it should be

submitted to the members. They thought that perhaps the best course would be to acknowledge the letter, and say that at the present time the Association had not formed any decided views on the subject; but, if it was considered expedient to hold a conference to discuss the matter, the Association would be pleased to send delegates. The Committee would like to hear the views of the members, and to receive their instructions as to the manner in which the letter was to be answered.

Mr. J. T. JOLLIFFE (Ipswich), called upon by the President, said he did not know that he held any very strong views on the point, except that he thought it was desirable, where possible, to standardize everything. When the subject was brought before the Eastern Counties Association of Gas Managers,* it was fully discussed; and it was then pointed out by Mr. John Glover that nearly 90 per cent. of the meter-unions in use were made to one standard. If this statement was correct—and he (Mr. Jolliffe) thought it was—it seemed to him that it rested entirely in the hands of individual gas companies to bring the meter makers to any standard they wanted. They could, if they felt so disposed, order that their meters should have the standards recognized by certain makers; and by doing this he thought they would get all that was wanted without going to the Board of Trade. If they went to the Board, they might have restrictions imposed which would cost the gas companies throughout the country a very large sum. He therefore proposed that a reply be sent to the communication from The Gas Institute to the effect that the Association could not see their way to make any proposal in regard to the matter at present.

Mr. H. H. JONES seconded the motion, which was unanimously adopted.

The PRESIDENT then delivered the following

INAUGURAL ADDRESS.

Gentlemen,—The first words which I feel it my pleasing duty to address to you in my capacity as your President, are those of most sincere and hearty thanks for the honour you have done me in electing me to this distinguished post. Though it is now over twenty years since, under my steadfast friend, my father, I first commenced my career in the manufacture of gas, I must still regard myself as a junior; and this fact, I am bound to say, adds very materially to the honour you have done me. Our esteemed Hon. Secretary has pointed out to me that my election is unique in that it establishes the principle of heredity in the

* See "Reports of Gas Associations" for 1898, p. 130.

presidency of the Association; for I am, I believe, the first President who can look back to the time when his father filled this chair. I trust that this incident may be the forerunner of others like it, and that many of you may see your sons and sons' sons so elected.

I regret that I have been unable to undertake any special research in order to make this address interesting, as the past season—I can hardly call it winter—has been such an exceptionally trying one at Tottenham, that it has entirely prevented any investigation of such a nature. I do not intend to weary you, if I can help it, with a detailed account of all our troubles; but with your permission I will mention a few.

In addition to such trifles as the water supply occasionally giving out, we had others owing to incomplete alterations. To make room for larger steam-boilers for stoking machinery, we had had to pull out one of our existing boilers; and the new ones which should have been delivered in July turned up in December, so that we were short of steam power.

On account of our retort-benches having become very old and dilapidated, we had last summer pulled down more than half of them for reconstruction on the regenerative principle. We thus reduced our coal-gas making plant to a capacity of 800,000 cubic feet per day; and as our greatest daily output is just on 3 millions, it is quite unnecessary for me to enlarge on the importance of our getting the rebuilt settings finished as soon as possible. After several anxious delays, owing chiefly to the difficulty of getting materials, some of the new retorts were charged on Nov. 4; and then it was that our troubles commenced. The rebuilt portion is constructed for mechanical stoking; and the machinery, which was to have been ready in October, is still unfinished. Neither the retorts nor the stages are suitable for hand charging; and the coals had to be got on to a floor, not made for the purpose, by a laborious and awkward method, and naturally the men did not take kindly to the work.

Most of the members, no doubt, have already experienced the troubles incidental to changing from direct to regenerative firing; but with the added difficulty of it being impossible to get a proper charge into the large retorts, I think we experienced the utmost limit of trouble. We had that usual accompaniment of gaseous firing, a plentiful crop of stopped ascension-pipes and hydraulic mains, in its most acute form. To such an extent did we have this trouble, that a gang of men had to keep right on clearing one set after another, though we had only four under fire; and day by day we had the depressing spectacle of large clouds of smoke

that should have been on its way to the station meter rolling away to add its quota to London's fog. Perhaps it ought to have been a consolation to us that it was helping to darken the air there, and increasing business for our "Chartered" friends. These were not very encouraging conditions under which to write a Presidential Address.

In all this trouble, the friend that stood by us, without a sign of flinching, was our American associate of four years' standing and trial; I mean the much-reviled carburetted water gas. If there had existed any statutory limitation to the proportion in which this gas might have been sent out, such as has been suggested, without any qualifying clause for cases of emergency, we should, I am afraid, have been face to face with the choice of either breaking the law or seeing our holders aground. If I carry the hypothesis further, and suppose that we, being so placed, had taken a *plébiscite* of our consumers, I am sure their unanimous reply would have been: "We do not mind about the proportion of water gas, but do not on any account put us in darkness."

In support of this statement, I may say that in our district we have had no opposition to the supply of water gas during the period of upwards of four years in which we have supplied it. This has not been for want of an attempt; for when we first started the plant, just before Christmas, 1894, we had to discharge many men who had been employed on its construction. This, coming at a time when we were usually taking on fresh hands daily, spread alarm among some of the "Labour leaders." They forthwith used the influence of their custom with certain publicans, who very soon spread it on to others of their calling. A public meeting, in the Theatre Royal, was then convened by handbill, and was attended by perhaps two score of people, among whom, counting press men, promoters, myself, and another official, there may have been eight or ten consumers. It was announced that an expert on gas would address the meeting. When he came forward on the stage my hair almost stood on end—I knew him. His business was to supply a material that would no longer be required on our works now that we made carburetted water gas. His argument was that coal was got in England and oil was not; and that in this Free Trade country people ought to support home industries to the exclusion of foreign ones. He did not say how much of his own particular material was the outcome of British production, or how much was not. He, however, admitted to me after the meeting that his object was to get a strong opposition to us, so that he might

use it in his business and prevent the spread of carburetted water gas, and thus save his trade.

Alas, for human hopes! There were then completed in Britain carburetted water-gas sets capable of producing 11 millions per day, including the 8-million cubic feet installation at Beckton; whereas, there are now in existence here machines sufficient for 86 millions per day. There were then only four works supplying it; now 57 have adopted the system, and still they come! These figures show the expert's efforts to have been in vain; and, the meeting altogether being a distinct failure, the fizzle ended. But there is a moral attaching to the tale; and it is this: Trade interest was thus early alarmed and at work. How far it has since been directly or indirectly responsible for most of what has been heard against water gas probably will never be known. Like most other cowards, it mostly stabs in the dark, or uses others to commit its outrages.

You are in for a strong dose of carburetted water gas to-day; and I hope it will have none of those baneful effects which have been ascribed to it. I have already indicated the rapidity of its spread in these isles; and in other parts of the world it has taken firm hold. Excluding the United States of America and Canada (which countries may be said to be its birthplace and nursery ground as a successful lighting agent), and excluding Dr. Strache's experiment at Vienna of lighting a hospital with water gas *per se* and Welsbach mantles, plants for the production of 7½ millions have been erected. In the same period, under the Dominion and States Governments, where the people have had sufficient of it to know whether or not it is good for its purpose, water gas has not been either going back or at a standstill; for during the past four years new plants for 93 millions per day have been erected by the best-known firms.

So far as my own experience of more than four years is concerned, I feel bound to testify that carburetted water gas has proved itself eminently suitable for public and domestic lighting, and that the lighting of our district is now more satisfactory than it was before. I do not claim for it that it changes human nature, and that we have ceased to hear the usual grumbles about quality which follow the delivery of gas bills in every town. But personally I would, if I lived at the works, have my house supply connected to the carburetted water-gas main, and use it in preference to coal gas.

As regards the quantity we have made, omitting 11 millions in December, 1894, up to the end of 1898 we have produced and distributed 907 million cubic feet, against 967 million cubic feet

of coal gas. This together is equal to 1½ years' supply at Belfast, or six months' at Liverpool. Yet, fortunately, we have been quite free from cases of suffocation. Of course, one cannot deny that accidents will sometimes happen, even in the best-regulated families, whether they use coal or water gas; but, as I have said, we happily have been free.

Unfortunately in some other parts of our country it has been proved that the Transatlantic mode of suicide has immigrated here; and I am afraid Coroners' Juries will sometimes, in future, be puzzled as to a correct verdict. Their task is simple when a body is found grasping a discharged revolver; but if in future such a body be found with merely the gas-jet turned on and unlighted, who is to say whether it is accident or design? Speaking of firearms, we do not find that gun accidents now are more frequent with the more powerful modern powders than they were formerly. This is because guns are better made. If, to adjust the parallel, I admit that carburetted water gas is more toxic than coal gas, I say that for this very reason it is a blessing; for it will tend to give the death-dealing water-slide its dismissal, drive the still more deadly tinkering gasfitter to an occupation more suited to his want of skill, and produce properly qualified and certificated craftsmen for such important work.

I am tempted to carry my simile a step farther and ask what difference it makes to anyone whether he is inadvertently killed by gunpowder or cordite, or whether by the escape of coal gas or water gas. Neither is intended, and neither should happen with reasonable care. Whether or not there may be any ground for inquiry into increased risk of using the gas, there is certainly a great deal to be said for the reduced risk of making it as compared with coal gas. But I will simply say our water-gas plant has been almost entirely free from time lost through injury since it was started. The workmen employed in the manufacture prefer it to coal gas; and this is an important indication.

Some unusual incidents in relation to the system may be of interest, so I will recount them. When we first started the plant, and for some time afterwards, a connection to the drains existed by means of which some of the water from the tar-separator could get away without our intending it. The drainage from this part of the works flows for some distance along a sedgy hollow by the side of the Great Eastern Railway; and the small particles of oil tar floating on the water thoroughly impregnated the grass and sedge. While the wet season lasted, and the hollow was full of water, nothing of this was observable; but when drier weather brought some of the sedge above the surface, one of

those fires so often seen by the side of railways occurred, and coming in contact with the grass, the ditch was soon ablaze. But being the middle of the afternoon, with plenty of men about, the flames were soon splashed out by the use of shovels.

Later on in the season, however, when the water had all gone, the occurrence was repeated—this time on a Sunday afternoon, when the works were shut down and only three or four men were about. I was called as soon as it started; and, telling the men to follow, I seized a shovel and ran to the spot, in the hope that I could beat out the fire. It was, however, spreading at a pace that plainly told it must burn itself out; and the only thing to be done was to stop its spread, and save the telegraph posts. I at once turned to with my shovel, and, with the men, cut a furrow across the sedge. We had barely time to complete it when we were forced back by the dense and suffocating smoke and fierce fire. In less than another half-minute of anxiety, I had the satisfaction of seeing the success of my plan. The fire lined up at our stop; and in about ten minutes from the start it was all over. The burnt part measured about 100 ft. by 12 ft.; and I cannot describe the blackness of the cloud of smoke, about 1½ miles in length, that floated away from that badly-made burner, keeping just above the house and tree tops. I must leave you to imagine the terror of the untechnical of the neighbourhood, when the news spread that the gas-works were on fire, and would soon blow up. The following day we dug in the remainder of the grass to save further conflagrations.

The next incident is of more value from an instructive point of view. News was brought to me at the office that tar was flowing in great volumes from the stack-valve of one of the sets. Most of you are familiar with the construction, and will appreciate the incredulity with which I received the information. But when I reached the plant and found one of the superheaters and a large area of the stage covered with a tarry pitch, there was no room for doubt. Investigation showed that what had happened was this: Tar as well as water had been spraying into the scrubber, and the spray had become choked. The seal had subsequently become simply a tar-seal; and the washer and scrubber were greatly heated. The operator, discovering this, had properly stopped gas making, closed his valve upon the outlet of the scrubber, and then proceeded to take out and clear the spray and replace it. Thus far all was right; but instead of waiting for the scrubber and washer to cool, he turned on the water This produced a large volume of steam, which, on account of the outlet of the scrubber being closed, had no escape except up the

take-off pipe, and there it had to force the tar-seal ahead of it. The heat of the take-off pipe no doubt helped to boil the tar to the top; and some of it, falling on to the hot checker-work of the superheater, produced such a rush of gas that the remainder of the tar was carried out at the stack-valve.

The incident I am now going to relate is an addition to this address, as it has happened after I thought I had completed it. Last Monday week (Jan. 30), at about 6.15 in the evening, I was at work in the office, when the night foreman rushed in and shouted, "Come over to water gas," and rushed out again. His manner caused me to lose no time; and when I came in sight of the place, I saw that the tar-separator was on fire. The separator is covered by 3 in. by 9 in. deals, and is ventilated by a 6-inch pipe carried to a height of 40 feet, with an archimedean cowl on the top. Four of the deals were removed from their position; and the engine-man had foolishly taken an ordinary lamp—his "safety" being out of order—to look into the separator. The result is easy to foresee—the explosive vapours fired, and the poor fellow was rather badly burned about the arms and face. I had the lifted planks replaced, and the whole of them covered with coke sacks; and the fire was soon smothered.

This completes our list of troubles for over four years' working. Tar was the cause; and tar may be said to be the sole cause of trouble in carburetted water-gas manufacture. Its production per 1000 cubic feet is only about half that of coal gas; but still it is enough to be somewhat of a nuisance. We first used the tar as boiler fuel; but though saving about 4 lbs. of coke fuel per 1000 cubic feet by its use, it was troublesome, as either the burners stopped or else the chimney smoked. We therefore determined to deal with it in another way, and commenced by mixing some of the tar with the coal to be put into the retorts; and later we injected more of it into the retorts by Mr. Herring's process. This was found to be a valuable use for the substance; and we continued to dispose of it in this manner until a market was found for it at a reasonable price. By consuming it in the retorts we estimated that, for every gallon used per 1000 cubic feet of coal gas made we gained an advantage of 1½ candles in illuminating power, with about 5 per cent. increase in the tar. When the opportunity came, however, we were glad to be free of the mess in the retort-house.

It is no news to tell you that the great drawback to the use or sale of this tar is its inclination to hold large quantities of water in suspension. A rough-and-ready test for the water is made by rubbing a small quantity of the tar in the palm of the hand,

when the water, if any considerable quantity be present, separates into distinct patches; but the only absolute test is by distillation. As shown by the latter, we sometimes work down to as low as a quarter per cent. of water, and run low for some days. Then suddenly the percentage of water may go up; and we have had as much as 60 per cent. This proves that under certain conditions of heat in gasifying the oil, very careful working of the separator efficiently separates the tar by gravitation; but sometimes other conditions prevail, and separation is difficult.

I have confidence that science will produce a simple means of separating two so distinctly different substances as these. I have myself—guided by the known fact that a filter-paper saturated by oil will filter oil from water, or saturated by water will filter water from oil—taken large quantities of water from the tar when it has been highly charged. Perhaps herein may lie a solution of the problem.

With one word more on the subject of water gas, I think you will have had as large a proportion of it as even I dare give you; and my last word is this: The State of Massachusetts passed a law to restrict the sale of carburetted water gas; and they passed another to remove the restriction. If we, over here, should in any degree copy their first step, I trust that we shall keep an equally open mind, as well as a widely open door, so that the second may follow in due course.

The race of the Nineteenth Century is almost finished, and next year will see the "last lap." It is therefore gratifying to find that at this stage gas is found to be still "going strong" in the competition for public and domestic lighting. We are rapidly getting the measure of our powerful rival petroleum; and now that it is promised some heavy handicapping by Parliament and the London County Council, we may soon hope to see it quite out of the running where gas can be supplied.

The system of supplying small consumers by means of prepayment meters, with free gas-fittings, has already given gas a very large foothold where petroleum formerly had entire and undisputed sway. Some parts of the district of the Tottenham Gas Company are samples of the very densely populated places around London. We do not, however, find that the residents, as a body, use oil lighting for any love of it, but because the initial cost of the installation is small for oil-lamps as compared with gas-fittings. This assertion is proved by our constant experience that, when a change of tenant occurs (which at some houses averages once in every three months), each successive tenant, almost without exception, uses the meter and fittings.

We fixed our first slot-meter in 1893. The number of slot consumers at the end of that and the succeeding years has been as follows: 68, 1250, 2658, 4323, 5740, and 7024 respectively. The corresponding figures, in cubic feet, for the gas consumed are: 170,000, 8,472,000, 26,252,000, 43,130,000, 64,324,000, and 85,880,000; and those for the percentage on the total private consumption, 0·06, 2 82, 7·76, 11·76, 15·42, and 18·91. These figures seem to indicate that we are only just getting into our stride against petroleum; and I believe we shall, in time, practically oust it altogether.

A great deal has been heard, especially last year, in some evening newspapers about the cause of danger in oil-lamps; and the flash-point of the oil seems to have been the chief consideration. The fact seems to have been overlooked that, even at normal temperatures, a high-flash oil will burn easily when it has a wick; and a table-cover, a carpet, or a woman's dress will readily serve that purpose. The determination of what high degree of temperature shall be the minimum flash-point of lamp oil, and what form of lamp will keep every particle of its oil (whether it be in the reservoir or on the wick) below that temperature in order to secure safety in use, will soon fall very considerably from its present seeming importance, if our rate of exterminating lamps be fairly representative of other towns and districts. Whether or not the first experiment in raising the flash-point will attain the success expected of it, or whether the limit will have again to be raised, it is certain that it will enable gas everywhere to compete with oil in price as well as safety and convenience, and thus hasten the desirable day when oil-lamp accidents will cease to occur for a reason corresponding to the disappearance of snake-bites in Ireland.

Into the general question of electric lighting I do not propose to go, except as it affects the districts with which I am associated. And so far as existing rivalry is concerned, there is very little to say, as we have only a few instances of private lighting. Of one house so lighted I was for a time the occupant, and thus had the opportunity of an every-day acquaintance of the system. I merely mention this by the way; but if anyone would like to know anything further on the subject, I will refer him to my wife, who was constantly urging me to put up gas-fittings.

Of course, in some of the local papers, in the District Councils, and at street-corner political meetings, when at a loss for a sound subject, there has been occasional agitation for the extensive introduction of electricity into the district; and to meet this in a friendly spirit the Directors of the Gas Company

decided, when promoting a Bill for other purposes, to endeavour to secure powers direct from Parliament for the supply of electricity, without obtaining them through the medium of the Board of Trade. In taking this course, I needly hardly say that no disrespect was intended to that very important Government Department. The sole intention was to facilitate the procuring of authority by including it in a General Bill, and thus saving the expense of separate procedure—not merely to the Tottenham Gas Company and others who might follow, but to the consumers themselves; for it must always be borne in mind that it is they who have to pay the cost.

However, it was decided that this innovation could not be allowed, and that authority must be sought separately as heretofore. The clauses (which correspond to the usual Board of Trade Order) were therefore dropped. But, still wishing to meet such demand as exists with open hand, the Directors decided to give notice to apply for powers under an Order of the Board of Trade. On this being done, they were at once opposed by the District Councils. The fever of municipalization was in the air; and the prospect of powers they might possess going to others, was more than municipal nature could stand. Perhaps it was thought they could supply electricity more cheaply than we could; but such a faith is scarcely comprehensible in a district which, while trying to manage its own water affairs, and charging a rate of 2s. in the pound on assessment for an unsatisfactory supply, finds it more profitable to contract itself out of its more appropriate business of dust removal. The result was that the Gas Company were saved the outlay to meet a very questionable demand, and a possible dead loss; and the ratepayers lost, through their representatives, the best chance they are likely to have for some years to come of a cheap supply of electricity accompanied by no risk of a heavy charge on the rates.

On the other hand, incandescent gas-burners for public and private lighting are every day becoming more popular, and are lessening the already small demand for electricity. In public lighting, one of our Urban Councils has already adopted the system entirely; another has done so very largely, and is constantly extending it; a third has commenced; while the fourth is now making inquiries which will probably result in its complete adoption.

In our district of England's present capital, we find it quite impossible, in maintaining the efficiency of the system, to keep anywhere near the average of mantles in the ancient capital —that pioneer city of incandescent lighting, Winchester. What

proportion of the extra mantles used is due to the difference in the sedateness of the inhabitants—especially the younger portion—or what to the extra traffic of our streets, I cannot say; but I regret to have to confess that, notwithstanding the greatest care, we are compelled to use, in keeping our burners in efficient order, an average of close upon eleven mantles per lamp per year. This breakage is, of course, enormous; but we are steadily reducing it by means of anti-vibration devices and careful attention. Great as the breakage is, however, it gives us the satisfaction of knowing that the streets are as well lighted as they would be at twice the cost by electricity.

For domestic lighting the incandescent system is becoming more and more popular; and we would not do otherwise than encourage it. In mantles put upon the market, most new departures, if they happen to be worthy an existence, meet with a sudden death by way of an injunction; while most of those that are allowed to survive ought, so far as honesty and merit go, to have an injunction. Even in the houses of my own friends, I have encountered miserable imitations which are the outcome of the present arrangement; and I cannot help thinking that a great deal might be done to protect the public, by the present masters of the situation, if only greater freedom in the sale of their mantles were allowed, and a more conspicuous trade mark attached so that no mistake could excusably be made by the purchaser.

Another system of lighting has recently had a great deal of attention; and it certainly has claimed its full share of human sacrifice—I mean, of course, acetylene. I do not, however, look on this gas as a rival to ordinary gas, as without doubt, should it ever become possible, in cost and safety, for it to be such, it will then naturally fall in line under our own colours as becomes one of our kindred. Its present scope, however, is confined mostly to those districts and places outside the sphere of ordinary gas supply; but the day may yet come when gas companies will take it into their ranks. They may even, at some remote period, use up their spent lime and coke, as well as their retort carbon, to make their own calcium carbide; and there are already indications that they may also thereby produce diamonds as a bye-product.

Matters affecting labour have been so prominent lately that I should not be justified in closing this address without a few words of reference to it, even though I run the risk of wearying you. So far as they concern the gas industry, the labour events of the year include increased pay of stokers, reduced hours of others,

the establishment of the Workman Director, and that wholesale system of life insurance, the Workmen's Compensation Act, which has now been in operation for seven months. The advisability of transferring the risk to companies who make life insurance their business has had to be considered; and most large undertakings have decided to form their own fund. This, to my mind, is by far the best course, as it leaves them, as employers, free, in the unfortunate event of an accident, to deal direct with those afflicted—guided only by the Act and a desire to do justice liberally and unhampered by any consideration of what their duty might be to the Insurance Company. Nevertheless, it is just as advisable for small concerns to insure against accidents as it is for a man with responsibilities and no capital to insure against death. However, I see little more need for a gas company insuring now than existed before the Bill was drafted.

I do not think the Act makes much real difference to good employers, among whom we may safely claim always to have been classed. Most gas authorities would at all times have compensated voluntarily almost or quite as liberally as the Act now compels. Most of them, too, by a slight additional contribution to the subsidized benefit club which exists on most works, and a modification of its rules, can even now be allowed to substitute that in place of the conditions of the Act.

At Tottenham, our interest in our men, although not going the length of profit-sharing or the extreme of special representation at the Board meetings, is probably more than that which any other trading concern in the vicinity extends to its employees. In addition to a benefit society, we have established a savings bank, paying interest at the rate of 5 per cent. per annum calculated on complete pounds of each monthly balance. This was started by the men's request, when the week's holiday was first given, with a view to their "laying by" for it, and as an "aid to thrift;" but judged by our majority, a workman with 16 hours a day hanging on his hands does not seem able to be thrifty. It is disheartening to find it so little appreciated; but it is spared for the sake of its "ten righteous." We work our men shorter hours than neighbouring factories and workshops, on the whole we pay better wages, we give a week's holiday in summer to the regular hands, and yet I sometimes think we get less loyalty for it. Most of our trouble naturally comes at the night shift, from men who have spent the evening in the public-house previous to coming to work. This is an unavoidable effect of the eight-hour system.

Though I speak chiefly of the Tottenham works, I take it that

it is typical of all its kindred; and I freely confess that my sympathies are far more with the mechanics of the works than with the stokers. I was therefore glad that, at the time when the stokers were recently given their 7½ per cent. advance in pay, some consideration was also shown to those upon whom I have always looked as the backbone of the operative staff, especially when any trouble or hitch has to be met and rectified in any part of the works. It does not much matter who the stoker is that puts the coal into the retorts, nor who he is that pulls out the coke. These operations do not want thought, education, or knowledge of the individual works. But the best fitter is the one who has grown up on the works from an intelligent lad to a skilful mechanic, who knows the works, and has thus become thoroughly acquainted with the details and peculiarities.

The consideration given to this latter class, when the stokers had their increased pay, was that in the winter months they start work at 7 o'clock instead of 6 o'clock, and have half an hour off for breakfast between 8.30 and 9 o'clock. In the summer months, they will start at 6 o'clock, and have onehour (from 8 to 9 o'clock) for their breakfast. They will then have time either to go home or make their breakfast at the works for themselves, whichever they choose. This is a reduction of working hours of over 5½ per cent. in summer, and over 11 per cent. in winter. Thus all our workers are to be congratulated; and it is to be hoped that we shall realize that promise which is always made by those who profess to be their leaders—namely, that they will take a correspondingly increased intelligent interest in their work.

I will now bring my remarks to a conclusion by reminding you that we, in this Association, have been rather severely taken to task by part of the Technical Press, and accused of lethargy. As your President, I must say I have not observed this condition in our meetings. But we are, as it were, unwarrantably put upon our trial, and we must not rest under the charge. According to our critic, what is wanted is something new and controversial introduced into our meetings. It is of no use for me to appeal to you to find a fresh subject on which to write—there are plenty of old ones which are not yet threadbare; but I do appeal to you to furnish papers, and to put as much disputable matter into them as possible.

I should like to suggest one thing which might be done to increase controversy—probably the suggestion itself will raise one—and it is that papers should be in the hands of the Secretary at least a week before the meeting, so that they may be

printed and posted to members three days in advance of the meeting. If this were done, my only fear is that members, having read the papers, might be satisfied, and stay at home. But my hope and belief is that they, seeing beforehand in what manner the subject was being treated, would cull such statistics of their own working as might bear upon the point, so as to attack or support the paper, and make the discussion as lively as even our good friend can desire.

Papers have sometimes indefinite titles. I have often, when hearing them read, wished I had previously known the line of argument; and I have abstained from offering any remarks for want of being definitely prepared. There can be no doubt the arrangement I have suggested would add greatly to the value of the discussions, as most statistics and statements would then be given deliberately instead of on the spur of the moment.

At the conclusion of the address,

Mr. W. D. CHILD (Romford) said he had been asked to propose a vote of thanks to the President for his address; and he could assure the members that it was a great pleasure to him to do so. In the opening paragraph of the address, the President alluded to the fact that his father had previously occupied the chair; and he (Mr. Child) had no doubt that it was a great pleasure to the father to see his son now filling that honourable position. In nominating Mr. Broadberry for the presidentship, the Committee had in their minds the useful life his father had lived both in his profession and in the Association; and they hoped to see the son following in his footsteps. The subjects that had been touched upon by the President were thoroughly up to date; they were of considerable interest to the members; and the manner in which they were dealt with would be very useful to them at some future time.

Mr. A. F. BROWNE (Rotherhithe), in seconding the motion, said the members had listened to the address with great pleasure and considerable enjoyment. He thought perhaps the dominant note was the frank and outspoken expression which they knew so well in their President, and which had so well become him on former occasions.

The motion was carried by acclamation.

The PRESIDENT cordially thanked the proposer and seconder for the kind words they had used in submitting the motion, and also the members for the hearty way they had endorsed them.

This concluded the business proceedings. The members afterwards dined together.

MANCHESTER INSTITUTION.

ANNUAL MEETING, FEB. 25.

This Meeting was held at the Grand Hotel, Manchester. On the members assembling shortly after eleven o'clock, omnibuses conveyed the party to the Gaythorn station of the Manchester Gas Department, where, under the guidance of Mr. G. Ernest Stevenson, the Corporation Gas Engineer, and Mr. J. Merrell, an inspection took place of the installation of coke-conveying machinery applied to a range of inclined retorts. It was working with admirable smoothness; and, in conjunction with the charging arrangements of the inclined retorts, engaged the attention of the members during the whole of the time they were able to give to the visit, apart from the other operations of the plant at the works. At the conclusion of the inspection, Mr. Haddock, on behalf of the Association, tendered to Mr. Alderman Bax, the Deputy-Chairman of the Gaythorn Station Sub-Committee of the General Gas Committee, the thanks of the members for allowing them the opportunity of being at the works; and the formal vote of thanks subsequently passed was duly acknowledged by Mr. Bax.

On the meeting being constituted for business after lunch at the Hotel—Mr. HADDOCK in the chair,

The HONORARY SECRETARY (Mr. S. S. Mellor, of Northwich) read the minutes of the Bradford meeting, held on Nov. 26, 1898, which were duly confirmed.

THE LATE MR. ROBERT HUNTER.

The HON. SECRETARY also read a letter from Mrs. Hunter, expressing her sincere gratitude to the members for their kind message of condolence on her bereavement.

ELECTION OF NEW MEMBERS.

On the proposition of the SECRETARY, seconded by Mr. SHADBOLT, Mr. William Buckland, of Chesterfield, and Mr. Hubert Russell, of Holmfirth, were unanimously elected members of the Institution.

The Report and Accounts.

The Secretary read the report of the Committee, congratulating the members on the continued prosperity of the Institution. During last year eleven new members were elected, two had resigned, two had died, and three had retired under Rule 17—leaving 134 members on the roll of the Institution. The Committee regretted to report that during the year the Institution had sustained severe loss by the death of two of its most valued members—Mr. W. Smith, of Hyde, and Mr. Robert Hunter, of Chester. Mr. Smith, it was remarked, was one of the founders of the Institution, and was most regular in his attendance at the meetings. In his capacity as Auditor, he had examined the accounts for the past fifteen years, with every satisfaction to the members. By the death of Mr. Hunter the Institution lost a member who regularly joined in the discussions at the meetings. He acted in the capacity of Honorary Secretary for a few years, and was a Past-President of the Institution.

The accounts accompanying the report were taken as read; and after some explanation as to certain of the items,

Mr. J. H. Brearley (Longwood) proposed, and Mr. G. S. Frith (Frodsham) seconded their adoption, which was agreed to unanimously.

Election of Office-Bearers for 1899.

Mr. R. G. Shadbolt, in proposing the election of Mr. G. E. Stevenson as Senior Vice-President, said it was most fitting that the Engineer of the Gas Department of the Manchester Corporation should be elected to this office in view of the title of the Institution.

Mr. H. Hawkins (Todmorden) seconded the resolution, and it was carried.

Mr. Stevenson, in thanking the members, said he wished he was able to devote more time to the Institution.

Mr. Chas. Wood, of Bradford, was elected Junior Vice-President. Mr. Thomas Newbigging was continued in the office of Treasurer; and Mr. Mellor was re-elected Honorary Secretary. Messrs. H. Townsend (Wakefield) and W. Carr (Stalybridge) were chosen to serve upon the Committee; and Messrs. Duxbury and Lamb were re-appointed Auditors.

Votes of Thanks.

Mr. J. Chew (Blackpool) proposed a vote of thanks to the Committee, the Secretary, and other officers, for their services during the past year.

The resolution having been carried by acclamation,
The PRESIDENT and SECRETARY returned thanks.

INTRODUCTION OF THE NEW PRESIDENT.

The PRESIDENT, in introducing Mr. R. G. Shadbolt as President for the ensuing year, wished to thank the members for the kind way in which they had supported him during his year of office, which kindness he was sure would be extended to his successor.

Mr. R. G. SHADBOLT then took the chair, and read his

INAUGURAL ADDRESS.

Gentlemen,—On rising to address you to-day, I must again ask you to accept my sincerest thanks for the honour you do me. Although naturally proud of such a distinction, I already find there is another side to the situation than that of personal gratification. It is certainly no light task to maintain what diplomats term the "*status quo;*" but when it comes to the guidance—however nominal that guidance may be—of an Institution so highly progressive, both in point of membership and quality of transactions, as ours, one feels his limitations and shortcomings as he never did before. The position, however, is not without its consoling feature; and this is to be found in the *personnel* of the Committee—formed as it is, both officers and members, of gentlemen of experience and energy, such as one can look to with certainty for advice and support. Given also the undivided assistance of members old and young, it inspires one with the belief that with a long pull, a strong pull, and a pull all together, we may make this—one of the closing years of the century—one of the most useful and successful in every sense of the terms.

In reviewing the district covered by our Institution, we find the manufacture and distribution of gas carried on under almost as diverse conditions as can well be conceived, although, taking the central and most thickly studded portion, the requirements are chiefly those of manufacturing towns. Still, taking the gas industry of the United Kingdom as a whole, it could not be better represented than by the district we cover. This being so, it would be manifestly unjust to occupy your time by much specializing; so with your kind indulgence I propose touching lightly upon those phases of our industry which present themselves the most readily to my mind.

Scarcely is there a department or branch of gas administration but can show some improvement and development of one kind or another—and that within comparatively recent times. In

fact, the whole industry would at the present moment appear to be pregnant with life and energy. From the purely commercial point of view, our business may be said to show a steady, irresistible increase, such as justifies us in unshrinkingly facing our critics, and enables us to give an excellent account of our stewardship. That this is no mere sentimental boasting, a reference to that infallible witness the Board of Trade Returns will show. Briefly stated, the authorized gas undertakings of the United Kingdom have, during the last ten years—the time we ought, according to some prognosticators, to have occupied in the process of dissolution—increased their gas sales to the extent of 40 per cent.; while the increased profit from those sales necessary to pay dividend and interest on the extra capital employed during the same period, stands at the ridiculously disproportionate figure of 7 per cent.

Yet some may ask: "How do we stand to-day compared with a more recent time than ten years ago?" The same reliable witness shall discover. The returns show that, comparing those bearing date 1898 with 1897, the increased sales of gas amount to 4·5 per cent.; and the increased amount placed to profit and loss account only 1·84 per cent.—a very similar state of affairs to that shown in the ten years comparison. This mode of expressing the advance made in the manufacture and distribution of gas will, of course, appeal most strongly to the commercial mind, and can also be understood by the man in the street. Indeed, any business or industry that is discharging its duty to the public in an equally efficient manner has every reason for self-satisfaction. The figures given above relate, as stated, to the whole of the authorized gas undertakings in the United Kingdom, of which we form no inconsiderable portion, as Lancashire and Yorkshire alone contribute 25 per cent. of the total gas made by those undertakings; and there is no doubt that the members of this Institution are well in the van, and contributing their full share to the rapid developments and improvements now taking place in the gas world. Albeit the commercial improvements effected are not due to chemical and engineering progress alone, for improved financing has also rendered valuable assistance. Anyhow, this combination has resulted in our providing the public with a gradually cheapening article, and rendering ourselves more and more indispensable in the process.

The chemical aspect of our operations is necessarily a fascinating one; and it may be taken as a sign of the times that the interest in, and study of, chemistry as affecting gas manufacture (equally with other manufactures) is spreading rapidly, and the

old reproach of rule-of-thumb working will soon be completely removed. Rule-of-thumb, by the way, is no monoply of the gas manager; nor was it ever so.

Surrounded as we are in our daily avocation by some of the most interesting changes, both chemical and physical, in the materials dealt with, it would be wonderful indeed if we did not develop the chemical side more fully. Opportunity is not given to all alike to acquire the laboratory training which is becoming more essential in the gas engineer every day. Still, there are many opportunities, even in the smallest works, of adding to our scanty store of knowledge, and, what is of still greater importance, the practical application of this knowledge from time to time.

No more fruitful field of labour and experiment can be found than the retort-house, especially in connection with the manipulation of fuel, thanks in a great measure to the advent of regenerative firing. This method of heating has been with us so long, and has become so firmly established, that we are in danger of looking upon it as the acme of perfection, and of imagining that no further improvement can be made. Whether this be correct or not, time will prove. Personally I am of opinion that further economies may be effected by such means as maintaining the fuel at one constant thickness, thus giving off a uniform supply of carbonic oxide. Also by the recuperation of waste gases from the settings, by means of which a certain amount of heat energy must be conserved. These two items alone are well worthy of attention, which can but result in benefits of one kind or another. Upon application to extended working conditions, the game may, of course, prove to be not worth the candle; but, so far as I am aware, it yet remains to be proved. Certain it is, from my own observations, that modifications, such as here indicated, are quite practicable.

Or as another direction for research, what can be more interesting—and at the same time more perplexing—than the process of condensation? As ordinarily carried out, the main if not the sole object is to reduce the temperature of the gas, in conjunction with sufficient surface contact or friction, to throw down or extract the tars, and incidentally the water vapours, contained in the crude gas. Close observation soon discloses the fact that the character of the gas, both chemical and physical, is not by any means constant under this treatment, and that too rapid cooling under certain conditions may bring about the transfer of some of the light-giving constituents of the gas to the tar-well, instead of to the gasholder. Further observation will disclose

the action of condensed vapours upon those still in the gaseous form. In fact, condensation may be carried to such a pitch, under abnormal conditions, as to almost denude the gas of its light-giving properties. This is, indeed, a region where the experimentally inclined may explore to his heart's content; and the deeper he penetrates, the more will he find awaiting him. It is at this stage that enrichment in the generating plant may be rendered partially inefficient or be materially assisted; and I may perhaps be pardoned if I here interpose a few remarks on what has come to be known as the self-enrichment of gas.

As coiner of the term, it will possibly not be thought irrelevant if I attempt to define its meaning. Primarily it may be said to mean the utilization of some of the constituents of the gas in its earlier stages of manufacture, which under ordinary conditions would be lost—*i.e.*, so far as their retention in, and beneficial action upon, the finished gas is concerned—and, secondarily, the manipulation or method by which this end is attained. I must confess my inability to furnish you with a ready-made theory of what actually occurs during the process of self-enrichment. But that something of a beneficial character does occur, has been amply demonstrated; and I prefer to approach the subject from a severely practical, rather than a theoretical or mystical, standpoint.

As described in a paper submitted to the Eastern Counties Gas Managers' Association, in September, 1896,* it was while experimenting from a theoretical point of view, that I was led on to what culminated in the self-enrichment process of to-day. The starting point was the returning of purified gas to the hydraulic main, with the idea of the more stable gas carrying some of the lighter hydrocarbon vapours forward, and thus running the gauntlet of condensation; and to further assist the returning purified gas in its mission, its vapour tension was temporarily raised by bringing the temperature up approximately to that of the foul gas. Yet, despite all allurements, the fickle vapours continued their downward career—absolutely refusing to be ensnared. Once possessed of the "returning" idea, it was not a great step from purified to semi-purified gas, in all its stages from the exhauster forward; and, having run this gamut, to vary the point of introduction of the returning gas within the limits of the ascension-pipe and exhauster inlet.

Without attempting to lead you through the vicissitudes of failure and success, suffice it to state simply the result of it all

* See "Reports of Gas Associations" for 1896, p. 291.

which is that a certain proportion of gas, at that stage of condensation where the tar is practically removed but some of the lighter vapours remain—such, for instance, as would quickly stain white paper brown—returned to a point on the foul main where the temperature of the foul gas approximates to 130° Fahr., will give enriching results up to 1¾ candles. Indeed, under favourable conditions, an enrichment of 2 candles has been obtained—viz., from 17 to 19 candle power.

That this increased illuminating power should be obtained at the expense of something or other, is but rational; and on looking round, the effect was found to be on the condenser tars. These tars measured 1½ gallons per ton of coal carbonized; and the extent to which they were affected is shown by the following analyses:—

	Per Cent. by Weight.		
	Without Self-Enrichment.	With Self-Enrichment.	Loss due to Enrichment.
Water	1·90	1·74	..
Crude naphtha . . .	8·10	7·57	0·53
Light oil	9·26	7·26	2·00
Creosote	25·57	22·00	3·57
Anthracene and heavy oil	21·48	19·35	2·13
Pitch	33·00	41·30	..
Loss	0·69	0·78	..
	100·00	100·00	..

From these analyses, you will notice that the loss occasioned in the condenser tar by the self-enricher is chiefly in the oils and creosote. Consequently it is but fair to presume that these contribute towards the results obtained. Although no exact analysis has been made of the vapours contained in the returning gas, those condensable under ordinary conditions evidently contain a large proportion of benzol. Three gallons of this condensate, allowed to stand for a few weeks in contact with the atmosphere, separated out to heavy oil, water, naphthalene, and very light oil.

At the time the foregoing results and tests were obtained and made, we were carbonizing at Grantham under the direct-fired system, and working at what some would call comparatively low heats. But during 1898, gas-making operations were transferred to a new retort-house, with all settings on the regenerative principle; and a certain amount of speculation was indulged in as to how the self-enriching method would act when carbonizing at higher heats, and presumably under less favourable conditions.

Subsequent events have, however, shown that results almost identical with those obtained previously may be secured under the altered conditions, by very little re-adjustment. Some 500 cubic feet more gas of fully 17-candle power has been obtained per ton of coal under the newer conditions and from the same class of coal as that previously used—viz., South Yorkshire. Valuable as are the enriching results obtained by this method, they are not the only advantages attending its use; for the experiences of others, as well as of myself, go to show that, properly applied, it is a certain cure for naphthalene troubles.

My own experience with it during this winter is very striking. The starting of the new retort-house previously mentioned put the self-enricher out of action; and owing to the thousand and one small items incidental to the situation, the enricher remained out of action until the winter season had well set in, and enrichment of some kind became necessary. Altogether it had been out of action from the early part of April until the beginning of November, when the necessary connections were again made and the enricher put to work. Scarcely had it come into action than naphthalene made its appearance, principally on the side of the district farthest from the works, and became very troublesome, particularly in those lamps fitted with incandescent burners. Examination of the enricher arrangements revealed the fact that the temperature of the foul gas at the point where the returning gas was introduced, instead of being 130° Fahr. as anticipated, ranged only from 100° Fahr. to 110° Fahr. Also the condition of the returning gas was not so oily as before. These discrepancies were remedied by the 130° Fahr. point on the foul main being sought and found, and the returning gas taken from the washer inlet instead of the outlet. This adjustment soon had an appreciable effect upon the illuminating power of the gas; and in less than three weeks the naphthalene troubles had entirely ceased, and moreover have not appeared since. This in itself is sufficient to my mind to warrant attention; and I trust the time is not far distant when the precise conditions requisite, and the exact actions taking place during the self-enrichment of gas, will be thoroughly understood by all concerned.

The remaining processes—washing, scrubbing, and purifying, not to mention the extraction of the cyanides—are all equally interesting to the chemist in their respective spheres. As we discussed the question of purification generally so recently as our last meeting, the less said on this head perhaps the better, and I will confine my remarks to the last of these processes—purifying; meaning the removal from the gas of all remaining

impurities after treatment in the scrubbers, &c., and that of course with the least possible cost.

The intermingling of oxygen at the purifier inlet is a certain means of prolonging the life and increasing the duty of the material employed; but it appears to have gradually fallen into disuse—the cost of producing the oxygen being presumably the chief reason. Anyhow, many of us resort to mother atmosphere despite the deleterious effects of the preponderating nitrogen—and with great benefit, too. Time and observation have shown that the action of atmospheric air may be greatly accelerated by a certain humidity, which, of course, minimizes in turn the action of the nitrogen by reducing the quantity of air necessary to achieve a given result. The exact degree of humidity necessary has so far not been defined; and as our old foe naphthalene puts in an appearance immediately an excess of moisture occurs, the business of the experimentalist in this connection is clear—viz., to define the exact proportion of water vapour a gas may contain without bringing about the precipitation of naphthalene in the solid form. Once this is defined, even approximately, the only drawback to the use of steam and air in purifying will have been removed.

The amount of research and experiment necessary to adequately deal with the various chemical problems as they present themselves demands much more time and attention than is at the disposal of the busy manager; and in the larger works the chemist has become quite indispensable. But all kinds of considerations conspire to bar the chemist from the smaller ones. Doubtless as the average size of gas-works increases, this member of the staff will assume his proper place. Especially will this be so if the manufacture of water gas spreads to any great degree, and restrictions as to the proportion of carbonic oxide be imposed. Meanwhile, the managers of smaller undertakings are placed at a great disadvantage in this respect; and I throw it out as a suggestion that those of our members who are in the happy position of having a chemical assistant, do, when convenient and desirable, allow him to render assistance to their less fortunate *confrères*. Having myself been assisted in this way by a kindly neighbour, I assure you it is a favour highly appreciated.

To divert our attention from the domain of the chemist to the province of the engineer, is but the work of a moment; yet, momentary as it is, it serves to show the great versatility required of the gas engineer of to-day. Not only must he be a thorough business man and somewhat of a chemist, but he must also undertake the designing, constructing, and final control of

the various plant and apparatus comprising his works. When visiting various works—especially of the larger type—as we are often privileged to do, how one is impressed at times with the dominating mind pervading the whole. In one instance, the impression will be that of general inadequacy, cramped, cabined, and confined in very deed; while in another it is like coming suddenly in contact with a refreshing breeze—capacity, ease of working, and a general sense of roominess and freedom, is depicted in every feature. These features are but the expressions of the guiding mind, which in turn is, to a very great extent, the product of his time.

If we pass over such items as the change in general design from the heavy ornamental, on the one hand, and plain flimsiness on the other, to a not unpleasant combination of form and utility, as expressed in most works of modern design, the principal feature and trend at present is certainly the increasing use of machinery in the handling of material. Fortunate indeed is the man whose works are of sufficient magnitude, and circumstances sufficiently propitious, to enable him, by the adoption of mechanical assistance, to minimize his dependency upon that most unstable of all factors the British workman.

Although machinery is in many instances utilized in such parts of the works as the purifying-house, it is naturally in the retort-house, coal-store, and coke-floor that the greatest scope exists for its successful application. Whether it take the form of machinery for horizontal or inclined retorts, there are few instances but (with a works sufficiently large to keep it well employed, and the initial difficulties once surmounted) will show improved all-round working by its adoption. Still, the factors to be accounted for are so many, and of such diverse characters, that each engineer must carefully weigh the *pros* and *cons* before finally committing himself to its use. In fact, like any other innovation, a great amount of discrimination is called for; and unless some distinct gain is to be secured, the shovel or scoop will hold the sway in this particular case a little longer.

Until quite recently, there has been no intermediate appliance available between the shovel or scoop and the manual machine —such, for instance, as could be used without the aid of breaking and elevating machinery, or where the retort-house working-floor is restricted in width. I believe, however, that those of us in this intermediate state are about to find relief, for a very simple piece of mechanism is now being placed before us which entirely dispenses with the skilled charger, and from its action under prolonged trial would appear to be economical in working.

It is simple and speedy, and promises to be useful in those works which are prohibited, from one reason or another, from participating in the use of any one of the various excellent mechanical appliances now in vogue.

But perhaps the boldest, and decidedly the most radical, attempt to eliminate manual labour from the retort-house, has emanated from within our own district, in the form of the revolving retort. Certainly no departure in gas manufacture was ever heralded in a more auspicious manner, or had before it a more promising outlook. Every attention was paid to the new arrival; and all kinds of wild visions were conjured up of the important part it was destined to play in our midst. Yet, brilliant as the outlook then was, at the present time failure is writ large upon it—at any rate to the superficial observer—and my excuse for calling your attention to what has erroneously come to be considered as a closed chapter in history is that the failure of this machine to effect its originally-intended purpose is no more certain than that the fascinating promises held out in the first instance have been assured.

It fell to my lot during the winter of 1896-7 to have placed at my disposal for testing purposes under every-day conditions a couple of these retorts, connected to a complete plant, with a view to ascertaining what might be expected of them in an ordinary way; and as these tests were to form the basis of negotiation between two other parties, every care was taken that nothing should be misstated one way or the other. Like most tests of this kind, hitches and stoppages of various sorts were the order of the day, and the longest run only extended to a little under three days. However, runs of sufficient length were made to demonstrate weaknesses and bring out difficulties that short trials would not reveal. The entire tests were carried out in three sets, the intervals being devoted to alterations and repairs; and as it is not my desire to weary you with a recital of the many difficulties encountered, I give below a summary of the results obtained in the first and second sets of tests, representing five runs in all of from 24 to 65 hours' duration each.

At this stage it was discovered that the illuminating power of the gas was quite at the mercy of the exhauster. Variations of either pressure or pull—so slight as to pass unnoticed on an ordinary gauge—proved sufficient to expel gas or draw in air, as the case might be, through the coal in the feeding hopper. This having been remedied by means of double gas-tight hoppers, and slight alterations made in the furnaces, the third set of tests was conducted with greatly improved results—viz., 9580 cubic

feet of 24-candle gas was obtained from similar coal to that used before, with a fuel consumption of 6½ cwt. of coke, as against 8·3 cwt. previously. Tar, liquor, and ash remained practically as before. The illuminating power during the first and second set of tests ranged between 16 and 20 candles, and was most erratic; while in the last set 24 candles was steadily maintained.

Product.	Yields.		
	Maximum.	Minimum.	Average.
Gas per ton of coal carbonized . .	8878 c. ft.	5557 c. ft.	7223 c. ft.
Coke ash	14·39 cwt.	12·42 cwt.	12·83 cwt.
Tar	25·07 gals.	7·13 gals.*	18·15 gals.
Liquor 2°†	29·91 ,,	18·33 ,,	23·48 ,,
Pitchy deposit ‡	133·60 lbs.	36·44 lbs.	60·83 lbs.
Coke used as fuel			8·30 cwt.

* First run, apparatus dry. † No added water, and scrubber inefficient.
‡ Formed in hydraulic main.

The two items which stand out more prominently than the rest in these tests—especially the first and second set—are the enormous quantity of coke consumed as fuel and the comparatively low yield of gas. Indeed, the most curious feature, apparent throughout, was that by altering the rate of coal-feed the yield of gas might be made to vary anywhere between 5000 and 10,000 cubic feet per ton of coal; the hourly output and illuminating power remaining fairly constant meanwhile. Undoubtedly heating difficulties were the immediate cause of this. As can be readily understood, the difficulties of heating a rotating vessel are much greater than those attending the ordinary system. Really no attempt worthy of the name had been made to meet the special requirements of the case, and as a result the greater part of the heat was dissipated; the method of applying it being such as to induce it to slip away past the sides of the retort, rather than to impringe upon the parts most in need of it. At any rate, such was the effect that not more than 4 tons of coal could be carbonized to anything like clean ash, as against 10 tons originally anticipated, per 24 hours. Less could not then be passed through as the gearing would not permit of it. Yet with this rate of feed the temperature of the retort would be lowered to almost a black heat at the feeding end within the first hour.

Little wonder that anything but satisfaction was felt under such adverse conditions, and that the position was further aggravated by equally adverse financial considerations. Such

a combination of circumstances could not fail to stay all experiments, at least for a time. Very briefly stated, the position is as follows: Certain definite although erratic, results have been obtained. Increased quantities of gas have been secured; and still the illuminating power of the gas remains unaffected. Or, in other words, that point where increased quantity is obtained at the expense of quality has not been reached; and until it is, who can declare the system an absolute failure? This is one of those instances which incline one to agree with the proposal made every now and again to use our organizations for research purposes; providing works where departures of this kind could be tested under the best supervision, and in an impartial manner. The obstacles, however, are many; and it will doubtless be some time yet before anything of the kind is actually accomplished.

It is not a "far cry" from the retort-house to the coke-floor; yet the transfer of coke from one to the other is often beset with difficulties. We may congratulate ourselves upon the opportunity offered to us to-day of inspecting one method of effecting its removal by mechanical means, designed specially to deal with conditions peculiar to inclined retorts. Ere long we may expect to find coke-conveyors almost as plentiful as those for coal. The mechanical handling of materials before and after treatment is perfectly right and proper, where consistent with economy; but when it is extended to the disturbing of solid material during treatment, the result is certainly more enigmatical. For example, the devices put forward from time to time with a view to continuously moving and displacing solid purifying material. Here are encountered at the outset, conditions which must be religiously observed and maintained—viz., a state of quiescence, time-contact being a prime factor—and I am afraid that efforts to adopt mechanical motion in directions such as this will not always meet with unqualified success. Speaking broadly, and judging from the present general trend, one may fairly expect that, in the near future, almost all the operations, especially in works of larger size, will be conducted with the mechanical regularity and precision so essential to successful working.

Let us now turn our attention for a moment to that side of the business which brings us most in contact with our consumers. To say that the use of gas for purposes other than lighting is rapidly increasing, is simply to repeat a truism. Still there are those who need to be reminded of the fact. I do not purpose adding anything to the published records of the various popular means which conduce to this end—indeed, to attempt the addition of anything to the slot-meter question, for instance, after the

excellent compilation of our President of twelve months ago, would be futile—but would rather direct your attention to the effect of these increased consumptions, especially that of the day output. The reflex action is such as to cause us ere long to revise our practice of pressure application. The larger undertakings find it necessary in some instances to carry high-pressure mains into the heart of the consuming district, and there distribute the gas at a suitable pressure. Those of us whose scenes of operations lay within more modest dimensions, though not called upon to project an artery of this kind, are nevertheless being compelled by force of circumstances to increase the day pressures of a few years ago. As instance the case of Grantham, where the day consumption may safely be classed as "domestic," as distinct from "manufacturing." Very few years ago, the orthodox 1-inch day pressure was considered ample; whereas now fully 15-10ths are required—not on account of small mains, but for the satisfactory use of various cooking, heating, &c., appliances. This would appear to indicate that, what with cookers, &c., in the day-time and gas-fires at night, particularly in the winter season, a constant pressure will very shortly become imperative.

The call for gas for lighting purposes pure and simple, is, generally speaking, steadily tending upwards. Some undertakings, such as supply manufacturing districts, may at times suffer temporary checks from the inroads of electricity—more particularly where the arc light is adaptable, and a surplus power is at hand. But the incandescent electric light, considered as a light simply, cannot yet oust even the humble open gas-flame, much more the incandescent gas-light. Yet there are doubtless many cases where its use is preferred from reasons other than economy; and in the larger towns these instances often reach such proportions as to warrant its introduction. My own observations and inquiries on this point have led me to the conclusion that the use of electricity for lighting purposes is not at all governed by its comparative cost with gas, unless it be in inverse ratio to what might be expected; that there is a certain craze for it; that it is considered by the fashion leaders to be more up to date; and, perhaps not least, that it lends itself better to ornamentation. Anyhow, there are instances of this anomaly—where comparatively costly electricity and cheap gas flourish side by side.

All are aware that there is really no comparison, on the score of either light or economy, between incandescent electric and incandescent gas lights; but they have one feature in common —they are both delightful examples of a gradually diminishing

quantity. Left to themselves, they slowly but surely assume the twilight stage, until, if the vital member be not replaced, you have difficulty in even locating them. So far as the incandescent gas-light is concerned, I believe many complaints of poor gas supply are traceable to it. Consumers have grown so accustomed to leaving gas-burners untouched for years at a time, that naturally the incandescent burner comes in for the same negligent treatment, with results disastrous to the suppliers of gas. As the mantles collapse from one cause or another, they are replaced, with grumble accompaniment; and the poor burner is left to burn its head off or choke itself up. An instance of this kind came under my notice last winter. The proprietor of a pea-picking shed, lighted throughout with incandescent gas-burners, complained of the waning light. Upon inspection, the burners were found to be literally choked in the bunsen tube, as well as the gas-jets being almost webbed over. This was doubtless caused by the exceptional amount of fine dust in the atmosphere; yet it applies to a greater or lesser degree wherever the burners are neglected. In connection with our street lighting at Grantham, the standing orders are that every time a mantle is renewed the burner shall be taken to pieces and cleaned. This averages with us five times a year.

The adaptability, with due care, of the incandescent burner to street lighting, has been so often demonstrated that it calls for little further comment. Let me say, in passing, that the high-power burners—such as the Denayrouze—give excellent results in lighting open spaces, and, light for light, cost about the same in maintenance as the smaller kinds.

Many of the members of this Institution are called upon to fill the post of secretary as well as that of engineer or manager, or both. To such, an exceptional opportunity presents itself to-day, in the form of the adjourned discussion on Mr. Brearley's paper on "The Balance-Sheet." This is a subject in which we are all of necessity deeply interested; and I trust it will receive at your hands that treatment it fully deserves.

From an administrative point of view, the gas industry never occupied such a sound position as it does to-day; and on the other hand, never were greater care and watchfulness required than at the present time. Those upon whom the administration of gas undertakings devolves, know full well that it behoves them to keep fully alive to every move on the board. To such, the so-called monopoly under which we now labour is simply protection against irresponsible interference and unwarranted friction—that they may the better devote their full energies to

the attainment of their one object, which is the provision of a medium of light, heat, and power in its best and cheapest form, consistent with due recompense from a master well served.

Time was, when the administrator, engineer, and manager had little in common. Gradually the respective duties have concentrated themselves, till now in many cases they have so blended as to become inseparably one, to the benefit of such undertakings. The reduction of official friction, and the unhindered operations of one guiding mind, are in themselves objects well worthy of attainment. This concentration, along with the higher *technique* of our business, demands that the competent gas engineer must be a resourceful and versatile individual—not a paragon of perfection by any means, but a highly trained specialist possessed of as much useful technical knowledge as is fairly possible to pack into the ordinary cranium. Then add to this the lessons of experience, and you have the finished product.

Now it is to the educational side of Institutions such as this that I would draw your attention for a moment before concluding. One very gratifying indication of the growth of the desire for mutual technical education is the formation of the Manchester and District Junior Gas Association, which has certainly met a felt want in the junior ranks, and cannot fail to exert a beneficial influence in time to come upon our own and the National Institute. May they go on and prosper.

We congratulate ourselves upon the continually increasing number of members, and not altogether without reason. Yet there are many within the district covered by this Institution, who no doubt peruse our transactions, or such as appeal to them, but never dream of themselves contributing to the general good, even by their countenance. A brief survey of what may be termed our sphere of influence, brings one to the conclusion that our membership roll should be at least 200—not that we are touting for members by any means; but there are at least 50 more fully qualified men whose sense of responsibility to their profession, and a general desire to be of service, should be such as to include them in our ranks.

To go farther afield, we make the astounding discovery that out of 1600 gas undertakings, large and small, in the United Kingdom, only 600 are represented on the membership rolls of The Gas Institute and the Institution of Gas Engineers, allowing for those who are members of both. In all probability, those 600 go largely to form the 750 members who comprise the various District Associations and Institutions of the country. Here is scope indeed; and upon the younger members of this

and kindred organizations rests the onus of improving matters. Our elders have played their part nobly and well, or we, as an individual Institution, should not be in the flourishing condition we are to-day; but there is work ahead, and work that is vital to the well-being of the industry itself.

The hand of death has laid heavily upon our older members lately; and we are deeply moved with regret at the losses thus sustained. Yet the world moves on; and we must do our part. Let the members of this Institution, old and young alike, but discharge their responsibilities faithfully and well, and I doubt not that we shall hand over to the century so nearly approaching, an Institution thoroughly suited to its purpose, and fitted in every respect to meet whatever demands may be made upon it in the future.

Mr. W. W. HUTCHINSON (Barnsley) in proposing a vote of thanks to the President for his address, said the keen up-to-date observation with which he had watched all processes put before the gas profession would commend itself to the meeting.

Mr. T. BOWER (West Hartlepool) said they would all agree that the Committee in bringing forward Mr. Shadbolt as a Vice-President, and subsequently as President, had come to a very wise conclusion.

The resolution was passed unanimously.

The PRESIDENT, in responding, said he had admired the many presidential addresses he had listened to in the Institution, but had never read one which gave him so little satisfaction as the one he had just delivered.

THE RETIRING PRESIDENT.

The PRESIDENT proposed that the heartiest thanks of the meeting be passed to Mr. Haddock for the services he had rendered to the Institution during the past year.

Mr. T. N. RITSON (Kendal) seconded the motion; remarking that the amount of time, thought, and energy which Mr. Haddock had devoted to the interests of the Institution well merited the resolution the members were asked to support.

The motion was carried unanimously.

Mr. HADDOCK briefly returned thanks.

ADJOURNED DISCUSSION ON MR. BREARLEY'S PAPER ON "THE BALANCE-SHEET."

Mr. BREARLEY said one or two circumstances had transpired since he placed his paper before the Institution which might

have led him to add something to the remarks he made at the previous meeting; and for the matter of that there were one or two statements made on that occasion which could be revised. But for the purpose of discussion it would be best for the members to have an opportunity of speaking on his remarks as first made.

Mr. THOMAS NEWBIGGING, in response to a call by the President, said if the remarks he was about to make should appear rather lengthy, he hoped members would bear with him as well as they could. The paper touched on many points to which reference ought to be made in the discussion. He would endeavour to infuse some interest into what he proposed to say; and he did not think he should experience any trouble in doing this, because Mr. Brearley's style was infectious. In the first place, he wished to congratulate Mr. Brearley on having provided a fruitful topic for discussion in his paper on "The Balance-Sheet," read at the last meeting, and also on the ability displayed in its preparation at short notice. It was only within the last day or two that he had perused it. He had not the opportunity of attending the previous meeting, and therefore did not hear the paper read. When he first saw the title of the paper, he came to the conclusion (naturally, he thought) that the matter dealt with was one of book-keeping—a question as to the preparation and arrangement of the balance-sheet, of the items embraced in it, and how they might best be displayed in the most lucid manner. When, however, he perused the paper, he found that, so far from its being merely a question of book-keeping or accountancy, it really opened up the very wide subject of the whole administration of gas undertakings, both those in the hands of companies and those owned by local authorities. After all, therefore, there might be a good deal in a name. The rose would no doubt smell as sweet by any other name; but they might be excused for misapprehending the subject of Mr. Brearley's paper on "The Balance-Sheet," when he really meant "The Administration of Gas Undertakings as Exhibited in the Figures of the Balance-Sheet." But a question of title was a comparatively small matter. There was the fact that a very wide and comprehensive subject was suggested for their consideration and discussion. The first point alluded to in the paper was that of the capital relatively to the quantity of gas sold. It was not to be expected that there should be uniformity in this figure throughout the country. It varied, and it would vary; and the causes were not far to seek. He had dealt with them at some length in another place; and it would be as well,

in order to round off this discussion, to briefly refer to them now. The cost of incorporation, as had been pointed out, where there had been strong and expensive opposition to encounter, bore heavily on some works, especially small ones. Then there was the cost of land, which varied considerably. The cost of erecting the works was often increased by the character of the subsoil. He knew, for example, of a works in Yorkshire, not very far from Longwood, where as much, or more, capital had to be sunk in foundations than in the superstructures. It might well be here retorted that the selection of such a site showed bad judgment. That might or might not be so. If no better site was available, then the expenditure was a necessity. Again, the nature of districts of supply varied a good deal. Some companies had a close and compact area—a town population almost exclusively. Others had wide and straggling semi-rural districts, requiring long lengths of mains largely unproductive. The cost incurred in distributing. plant in these respective cases must vary to a considerable extent. Then it made a difference in the relative capital expenditure as between a place where a large proportion of the plant had to lie idle during a good part of the year, and another where there was a fairly steady consumption by all the consumers all the year round, or where, as in popular watering-places, they had two heavy consuming seasons each year. There was a further thing which went far towards accounting for the relative difference —that was, where a company were working up to the hilt as regarded their producing, storing, and distributing capabilities. It was evident that in such a case the capital per million cubic feet would for the time being be low. But let the company carry out the necessary extensions—and such extensions must always be larger than immediate needs—and it would be found that the capital per million cubic feet would go up at once. If besides these things they took into account the bad and wasteful engineering that some gas undertakings had suffered from, in badly designed works—immediately an extension was required, a large portion of the existing buildings and plant having to be displaced at a sacrifice—they would be able to appreciate why there should be such a difference, relatively, between one gas company and another as regards the capital per million cubic feet. But take the average capital of the companies throughout the United Kingdom, and it would be found that for the year 1897 it amounted to £659 per million cubic feet of gas sold. Ten years before (in 1887) it was £665; and fifteen years before (in 1882) it was £724. So that there was a gradual reduction taking place in the average. He had purposely left out of the calculation the corporate under-

takings, because the figures in these cases were vitiated by the premiums paid on taking over a concern from a company. It might also be pointed out in this connection that, in established gas-works, the future complete extensions could be carried out at a cost of £350 to £500 per million cubic feet of gas sold—the rate depending upon the size of the works. So much for the capital per million. He agreed with the writer of the paper on the great lack of lucidity and simplicity in the accounts of some corporate undertakings. They seemed to be compiled with a view, not to reveal the inner working of affairs, but to cloak and confuse the actual results as far as possible. This, in his opinion, did not arise from any intention to hide matters; it was really only an indication of the want of a systematic and methodical mind at the helm of affairs. He used the word "helm" advisedly, because nothing contributed so much to things getting adrift as the lack of a good, competent, clever man at the financial rudder. He thoroughly endorsed the view of the writer of the paper as to the rating question. Many gas-works were grossly over-assessed. Assessment Committees persistently refused relief; and Quarter Sessions, against whose decision there was no appeal, unless upon a point of law, were far from being a satisfactory tribunal to try cases of this kind. A revision of the method of rating was much needed. Mr. Brearley expressed the opinion—with which most or all of them would be ready to agree—that where the local authority had control of the gas supply, the consumers should not be fleeced on behalf of the rates in addition to providing a sinking fund to redeem the capital. The extent to which this unfair policy was carried out had been moderated of recent years, and should be entirely discarded. In Manchester, not so very long ago, the gas consumers were very severely handicapped (not to use a stronger expression) by reason of the policy that was pursued, and the system of accounts employed. In the accounts there was the usual sinking fund for the redemption of capital; there was, in addition, what was called a depreciation fund, notwithstanding that wear and tear and renewals were charged to revenue; and, to crown all, the public lighting was supplied free, and huge sums in addition from the gas profits were credited to the general fund in reduction of rates. Like Issachar, the strong ass, the gas consumer crouched down between, not two burdens, as the scripture had it, but under a multiplicity of burdens. [By the way, Issachar was, he remarked, not intended as a pun on the name of his friend Isaac Carr, as some might be inclined to suppose. He revolted against his *one* burden, and managed

eventually to kick it off.] Well, those were the days in Manchester when administrative ability and scrupulous finance were scarce and dear, and the flesh and blood of gas consumers was cheap. Happily, an amelioration in these respects had taken place of late years under the enlightened policy of the present Chairman of the Gas Committee and Mr. Nickson, not to mention Mr. Stevenson. But there was room for further improvement even in Manchester. The writer of the paper referred to what he considered the anomalous position which statutory gas companies held in not being able, owing to parliamentary obligations, to effect a reduction of capital. There was really no hardship in this—as a matter of fact, there would be a hardship in being compelled to do it. No company could possibly, or would seek to, gradually wipe out their capital. How could they? The only effectual way of doing it would be to adopt the method which was deprecated—namely, to burden the present generation of consumers for the benefit of the consumers of a future time. The capital—that was, the shares or stock—was bound to remain unredeemed, and, indeed, to be increased as required for extended business. If it were otherwise, it would not be a company at all, but a mere financial snowball, melting away under the rays of the sun of prosperity. All stimulus to enterprise would utterly vanish. It had only to be looked at, to see that such a principle would be entirely wrong. It was sufficient to take care that the property—that was, the buildings, apparatus, and plant—was kept scrupulously up to its proper value by charging the full wear and tear and renewals against revenue year by year. The effect of the auction clauses now introduced into all Gas Acts was virtually to prevent the growth of an inflated capital. Even in the case of corporate gas-works, it was questionable policy to go on wiping out the capital—most certainly it was wrong to insist, as the Government Departments did, on repayment within the brief intervals of twenty to thirty years. The gas industry was not a moribund industry—who among them believed that? On the contrary, it was very much alive—never more alive than at the present time. The way to handicap it, however, was to insist on burdening the present consumers to redeem the capital at short terms for the benefit of posterity. Corporate gas committees, managers, and secretaries should look closely into and study this question. It was well worth their attention. On the question of the cost of wear and tear and renewals, Mr. Brearley had something to say. His contention was that 3d. or 3½d. covered the cost of these, as against 5d. usually adopted by the

experts.* In this, however, Mr. Brearley laboured under a grave misapprehension. The 5d. of the experts—which he (Mr. Newbigging) contended was about right—included the repairs, maintenance, and renewals of mains and meters, as well as works proper; and if Mr. Brearley would add the cost of repairs and renewals of mains and meters to his 3d. or 3½d., he would find that the figure of the experts was a proper one. That was to say, it required on the average 5d. per 1000 cubic feet of gas sold to repair and maintain works, mains, and meters, and to reproduce them when worn out. As a matter of fact, he had taken the trouble to work out the cost of repairs and renewals of works, mains, and meters; and it came to a fraction over 5d. per 1000 cubic feet of gas sold. It was to be wished, therefore, that the paper might be corrected in this particular by deleting, or by altering, the paragraph dealing with this question. The poor experts, he observed, often come in for a share of scarcely deserved obloquy, either by open word or innuendo. In his opinion, their fees were earned very hardly, and they richly deserved what fees they got. Theirs was anxious and responsible work—none more so. To qualify themselves, they had to serve a long and often weary apprenticeship for but scant remuneration; and, next to barristers, their brains were continually on the rack. He supposed if their services could be dispensed with they would not be employed. No doubt they were like the family doctor—one did not like to see his carriage too often at the door; but the service they, like him, were able to render, was not to be despised. One thing he knew—their clients were often richer by many thousands of pounds than they would otherwise be, by reason of the experts' devotion to their clients' interest. In conclusion, he was glad that Mr. Brearley had brought before them a subject that gave plenty of scope for thought and discussion. His example should inspire and encourage the younger members

* The following editorial note was appended to the report of the proceedings in the *Journal of Gas Lighting* for Feb. 28, 1898: In regard to this remark, we learn from Mr. Brearley that this particular portion of his paper was struck out after the MS. was in type for the Bradford meeting, and before the paper appeared in our issue for Nov. 29, 1898. By some inadvertence, however, the lines were replaced in the Institution's official report and in the slips which were handed to the members preparatory to the discussion on Saturday. Mr. Brearley, on this subject, writes: "As I did not go through the reprints last week, I could not, even if I had desired, correct Mr. Newbigging's misapprehension, as I could not feel absolutely certain until I had looked the matter up. I had, previous to the Bradford meeting, been made aware of the items included by experts in getting out repairs of works rate."

of the Institution to come forward with papers. There was no subject, however much it might have been threshed out, but could be presented in a new and unexpected light; and every process of gas manufacture and detail of gas administration would still bear the weight of many papers and discussions.

Mr. ISAAC CARR (Widnes) said there was much in the paper which commended itself to him. The question of municipal management was one he had himself dealt with; and he quite agreed with Mr. Newbigging that the way in which many towns were treated in this respect was a great shame. They could derive some satisfaction from the fact that the bygone colossal amounts which had been taken were gradually being reduced; and he thought they could look to the healthy competition of electric lighting to bring them down still further. In time to come they might be given up, not only in justice to the consumers, but through sheer force of circumstance. He was quite sure that the gas industry of the future must rest on its own basis, and that it could not go on carrying other loads besides its own. With regard to the cost of maintenance mentioned in the paper, he had looked down the figures with some degree of interest, and was much more inclined to throw in his lot with Mr. Brearley than with Mr. Newbigging. The latter gentleman talked of 5d. as a proper figure, and one which might be useful in rating appeals. But however useful it might be in this respect, while it was right and proper to spend a sufficient amount on works, he contended that in the average works, such as those of which he had knowledge, the charge of 5d. for maintenance was too high.

Mr. NEWBIGGING said this figure covered both maintenance and renewals.

Mr. CARR said many of his colleagues had charged him with not maintaining his works properly because his figure for maintenance, renewals, &c., was a remarkably low one. His reply was that if he was not maintaining the works properly they would suffer and tumble down; and the fact that they were well kept up, that the whole of the plant was good and sound, and that the necessary repairs were annually executed at the figure he adopted, was a sufficient justification for its adoption.

Mr. NEWBIGGING said Mr. Brearley limited his 3½d. to works only, and did not include mains.

Mr. CARR said, whichever way it was taken, in his opinion the figure of 5d. was too high. Passing on to the question of capital, he said a remarkable lesson was to be gathered from the table Mr. Brearley was good enough to put before them,

showing amounts varying from something over £1000 to £330 per million cubic feet sold. Of course, as Mr. Newbigging had very properly told them, local conditions affected cost of works; and besides this there were engineers who had old-fashioned and extravagant ideas. The day for such ideas had gone, and it was no longer possible to lay out on the construction of works the money formerly expended on them. He did not want to talk too much about himself; but, as an instance, he would say that he had recently reconstructed the works at Widnes, and they were capable of producing double the quantity of gas they were selling at the present time, while their capital per million cubic feet, working up to half their capacity, was almost the minimum figure given by Mr. Brearley. He was personally indebted to that gentleman for having brought the subject forward in the able manner he had done, as it was one which appealed to all of them. He could not understand how the matters contained in the paper could be separated from gas-works management.

Mr. H. TOWNSEND (Wakefield) said he had been anticipated in a great deal of what he wished to say. He had noticed the fact that Mr. Brearley's figure of 3½d. did not include the repairs of mains, services, and meters. He was rather grieved to see the figure stated in such unequivocal terms, because if Mr. Brearley should have the misfortune to have his assessment put up, he might find his figure brought up in evidence against him, and be rather difficult to refute. He (Mr. Townsend) was glad Mr. Newbigging had drawn attention to this; and he wished to emphasize what that gentleman had said. As he read it, the item of repairs and renewals was not so much what was actually spent as what ought to be spent. The whole system of rating was hypothetical; and he agreed with Mr. Newbigging that 5d. was the least at which ordinary gas-works could be maintained.

Mr. NEWBIGGING remarked that this was the actual average figure throughout the country.

Mr. TOWNSEND said Mr. Brearley stated that "any undertaking whose Special Act incorporates with it the Gas-Works Clauses Act of 1871, is, according to clause 35 of the latter, liable to a penalty of not less than £2 per day so long as the accounts are not made out in compliance with the particulars specified in Schedule B annexed to that Act. This schedule clearly interprets that new meters not in place of old ones should be charged to capital." He had read the Act very carefully to see if he could attach that meaning to it, but had failed to do so. He believed such a meaning had been sustained in the Courts, although it did not seem to be in accordance with the Act. He read it as

meaning that this section really related to the facilities which were to be afforded to the public authority to examine the company's balance-sheets; and the penalty seemed to apply exclusively to any failure to send the balance-sheet. It sometimes happened that a company under the sliding-scale who were entitled to pay a certain dividend, and a little higher one on reducing the price of gas, did not declare that dividend, but, as they were entitled by law to do, placed the amount to the credit of the reserve fund. Supposing a company were unable to get any but very expensive capital, and in order to keep it down, charged to revenue a certain amount for new meters, the only people to benefit were the consumers—perhaps not at that particular date, but in the future; and the present consumers could not complain because the company were entitled to pay an extra dividend. It seemed very hard, if it were the law, that they were penalized in the way stated by Mr. Brearley. Supposing a company wanted to modernize some antiquated plant, for portions only of it ought the charge to be placed to capital; the other portions should certainly be charged to revenue. But in cases of this sort, it very often happened that the amount which clearly belonged to revenue would be sufficient to swamp the profit made for that half year. In circumstances such as these, several reputable companies had placed the sum to a suspense account, and paid it off out of future profits. He had looked very carefully through Schedule B, and saw no mention of a suspense account; so that, according to Mr. Brearley, those companies who were carrying out their obligations in a legitimate manner would be liable to a penalty of £2 a day. Some companies were in the habit of paying their dividends clear of income-tax; whereas in "Michael and Will" it was stated that the income-tax must not be paid in addition to the prescribed rate of dividend. He sought in vain in this authority to find out what the prescribed rate of dividend was in the case of a company working under the sliding-scale. Did it include the amount paid over and above the standard dividend which was allotted by the sliding-scale? Supposing they were entitled to a certain dividend, and as in the case he had instanced, they did not declare it, were they then entitled to pay their dividend clear of income-tax?

Mr. NEWBIGGING: Yes.

Mr. TOWNSEND said he was very pleased to hear it. He concluded by thanking Mr. Brearley for his interesting paper.

Mr. W. WHATMOUGH (Heywood) referred to Mr. Brearley's remark that, generally speaking, the accounts afforded a rough

idea of the stability or otherwise of the financial side of the undertaking, and that this stability was more apparent than real. This, according to his experience, was certainly the case with corporate undertakings. In his own case, when the works were bought by the Local Authority, the share capital was £30,000, and annuities at the rate of 10½ and 7½ per cent. were granted. This appeared in the balance-sheet as an item of £30,000; and it remained so till the year 1881, when the capital account was raised to £62,500, although the interest on the capital was the same. In 1897, the annuities were converted into stock; and the purchase was effected on a 3 per cent. basis, which really put up the capital £20,800 more. Thus, strictly speaking, their capital appeared at £53,300 more than it did when the concern was purchased. The rate per million cubic feet sold worked out at £1280, whereas it was only £774 on the original basis. With reference to the question of the valuation of gas-works, which had been referred to by Mr. Newbigging, he thought some united action ought to be taken. There was no doubt that some works were very heavily assessed; and if the Manchester and kindred Institutions were to combine in obtaining legislation to remedy the evil, it would be of immense advantage.

The PRESIDENT said the whole question, to his mind, apart from the amount originally expended as capital in putting down a works, resolved itself into this: What should they charge to capital and what to revenue? Each undertaking had to depend on its own circumstances and conditions.

Mr. BREARLEY, in reply, thanked the members for the kind remarks made respecting his paper, and for the way in which it had been discussed. He agreed with Mr. Newbigging that the title of the paper was rather misleading; but he must crave the indulgence of the members in this respect, as the time in which he had to consider either title or paper was very limited. He quite agreed with what Mr. Newbigging had said about Quarter Sessions, and that taxing gas to relieve rates was an injustice. He also concurred in what that gentleman had stated about the Local Government Board; and if he were in the unhappy position of being an expert, he should strongly recommend a corporation to go to Parliament for their borrowing powers. If his paper were read through, it would be seen that he did not deal with the question of repairs to mains and meters. His rate of 3½d. simply covered the maintenance of works, and not the rate which the experts got out when a transfer took place. Mr. Newbigging had found that the rate was over 5d. But in

all probability there were large sums placed to revenue which ought to go to capital for things that were not legitimate repairs. New meters and new works were put into revenue instead of being capitalized; and it was this that swelled the figure up to 5d. He congratulated Mr. Isaac Carr on the remarkably low rate obtaining at Widnes. He thought that Mr. Townsend's remarks were somewhat beside the question. A company paying extreme dividends ought not to put items to revenue which should be capitalized. In that case the company should reduce the price of gas. Schedule B of the Gas-Works Clauses Act should be read in the spirit intended—viz., that all items not for renewals should be placed to capital. He quite agreed as to the necessity for a suspense account when altering large works; and no doubt the reason such an account was not mentioned in Schedule B was because Parliament did not then realize that large amounts might be required for renewals in one year. He concluded by again thanking the members for their reception of his paper.

The business then closed.

The members afterwards partook of high tea, and spent the evening together.

MIDLAND ASSOCIATION.

ANNUAL MEETING, MARCH 2.

This Meeting was held at the Grand Hotel, Birmingham; and there was a fair attendance of members—about fifty out of a total of something under a hundred. The PRESIDENT (Mr. J. S. Reeves, of Bilston) occupied the chair.

The Honorary Secretary (Mr. C. Meiklejohn, of Rugby) was unavoidably absent from the meeting; and Mr. A. Cooke, of Oldbury, kindly undertook the duties of the position—reading the minutes of the last meeting, which were confirmed.

ANNUAL REPORT AND ACCOUNTS.

The twenty-first annual report of the Committee was then presented, detailing the transactions of the Association during last year, and notifying that eight new members had joined, two had resigned, and two had ceased membership under Rule 15. The accounts submitted showed a balance in favour of the Association of £93 5s. 6d.

Mr. T. GLOVER (West Bromwich) proposed the adoption of the report and accounts; and his motion was agreed to without discussion.

NEW MEMBER.

On the motion of Mr. W. A. SAPEY (Tamworth), seconded by Mr. R. KING (Wolverton), Mr. George Duncan, the Manager of the Melton Mowbray Gas-Works, was elected a member of the Association.

The PRESIDENT then read the following

INAUGURAL ADDRESS.

Gentlemen,—Before proceeding with my address, permit me to thank you sincerely for the honour you have done me in electing me President of the Association. Though I have considerable distrust in my fitness for the office, yet with the support you will give me I hope I may be able to discharge its duties to your satisfaction.

I feel sure you will agree with me in regarding the preparation of what is usually dignified as the President's Address as a task of increasing difficulty. So much has been said, and well said, about the details of gas-works construction and management, that it is well-nigh impossible to find anything new to say about them. There, however, is one safe method of procedure which may be adopted when making the attempt to interest the members of this and kindred Associations, and that is to state one's own experience and practice in the conduct of the undertaking for which one is specially responsible. Generally the principles we follow in our separate undertakings, and our methods of working, reflect pretty accurately the opinions we individually hold on such matters; and it may not be unfair to assume that the particular works of each manager are an expression of what, under the circumstances, he considers best.

Of course, obstacles sometimes prevent a capable man from bringing his works up to the standard of his opinions; but these obstacles must eventually disappear, and his works, although possibly by no means model ones, will have all the essential parts of such, and be well ordered and efficient. In view of these considerations, and in the absence of newer and more attractive matter, I venture to give the methods of working I have found it convenient to adopt in connection with the undertaking of which I have charge. I have no novelties to discourse about, for what I have adopted has generally had its value demonstrated elsewhere.

With respect to retorts, these are set eight in a bed, ⌂ shape, 22 in. by 16 in. by 20 ft. long, stopped off in the middle. They are heated by regenerative furnaces of the kind known as Klönne's, with some modifications introduced by one of our esteemed Past-Presidents—Mr. R. O. Paterson, of Cheltenham. These settings—some of which have been working for six years—continue to give great satisfaction. The normal output of gas per mouthpiece per day is 8000 cubic feet, with an expenditure of fuel of about 13 per cent. There is no need for anyone here to proclaim the superiority of regenerative settings over the old-fashioned direct-fired ones. Their almost exclusive use throughout the country attests their value. The advantages they offer in the economy of fuel, facility of control, and more regular heats, must eventually cause them to be universally adopted.

Along with the adoption of regenerative firing came, in my case, the abolition of hydraulic mains, and the insertion of a separate valve to each ascension-pipe—a system which, as you are aware, has been in operation at the Cheltenham Gas-Works

for more than thirty years. Happily with the hydraulic mains has also disappeared much of the trouble and the annoyance of pitched-up mains which seemed inseparably associated with that time-honoured and, in some respects, beautiful piece of apparatus. There is a further advantage gained by dispensing with the so-called water-seal—but what in practice often proved a tar-seal—and that is an increased yield of several hundred cubic feet of gas per ton of coal carbonized; a result well worth our notice.

The gas, on entering the foul main, is at once separated from the heavy tar, and then traverses a line of 18-inch cast-iron pipe running round three sides of the retort-house, to the condensers proper. The condensers are formed of several tiers of 16-inch cast-iron pipes, set horizontally with a slight inclination from the inlet to the outlet. The pipes are placed in a lean-to house formed of corrugated sheets, and amply protected against undue variations of temperature. I am convinced that the deposition of naphthalene in works, mains, and distributing plant, is frequently and largely due to great variations in the temperature of the gas while undergoing condensation.

Condensers placed so as to receive the sun's rays, and with no protection against frosts at night, must be irregular and sometimes interrupted in their action. With the arrangement I have in use—which also includes provision for the admission of a little steam when necessary—there is no difficulty in maintaining in the coldest weather a normal temperature of about 60° Fahr. at the outlet of the condensers.

From the condensers, the gas passes to the exhauster, and is then sent through a washer giving a seal of from 4 to 6 inches of ammoniacal liquor, which has the effect of pretty thoroughly removing any particles of tar the gas holds in suspension. The gas then passes through two tower scrubbers, one of which is filled with Livesey boards, over which is continuously pumped a stream of ammoniacal liquor. The second scrubber is filled with coke, through which flows a stream of clean water, delivered intermittently through a tumbler and distributing pipes. I do not think any advantage can be claimed for this type of scrubber over the more modern "Standard" washer-scrubber type; but the tower scrubbers have been working satisfactorily a good number of years, and there has been no occasion to discard them for others. We obtain from 30 to 32 gallons of 10-oz. liquor per ton of coal carbonized—a result which, I think, will compare favourably with those obtained elsewhere.

Our purifying plant, which is relatively large, consists of two sets, with four boxes in each set. One set (22 ft. by 16 ft.) is

filled with lime, and receives the gas first. The other set (16 ft. by 16 ft.) is charged with oxide. The lime purifiers are worked in the proportion of one of lime to three of oxide; the lime taking up more or less the carbonic acid and sulphur compounds.

As an aid to the revivification of the oxide *in situ*, and as a means of lessening the cost of purification, for the last two years I have adopted the plan of introducing 1½ to 1¾ per cent. of air into the gas. A small Roots blower is fixed in the engine-house, and is worked by a belt running over the shaft of the rotary exhauster. Air is passed from the blower through a meter, and delivered into the foul main over the retort-benches. There being no hydraulic main, the air is introduced to the gas at a point where its temperature is highest, and where presumably the tarry hydrocarbons held in suspension in the gas most abound. It has seemed to me that if carburization of air is at all possible without artificially heating the tar, this is the point where the air should be admitted. In my case, so long as the quantity of air admitted has not exceeded 1¾ per cent., I have not found that the illuminating power of the gas was deteriorated in the slightest degree; while the effective duty of the purifying materials has been enormously increased.

On several occasions more than 11 million cubic feet of gas have been purified per box, against less than one-fourth of that quantity purified under ordinary conditions. As may be expected, much more gas is purified per box during the summer than during the winter months. This is no doubt due to the increased energy of chemical action at the higher temperatures, together with the slower movement of the gas through the purifiers. The deleterious effects of air when admitted into coal gas under ordinary conditions has probably prejudiced its use; but if the air is employed in the way, and in the relatively small quantities, I have described, not only need no mischief be apprehended, but a most satisfactory gain may be secured in the reduced cost of purification. The apparatus required is of a simple character, and needs little attention. The important feature of the method is that air is introduced to the gas when it is at its highest temperature, and when it is saturated most fully with tarry hydrocarbons.

Going outside my own personal experience, I think the extension of water-gas plants during the past year has not been quite so marked as in previous years, which is probably due to the better prices obtainable for coke, and the anticipated restrictions which the Government may place upon the use of water gas. There is, however, in my judgment a very distinct advantage

in having a water-gas plant as an auxiliary to fall back upon in case of a sudden demand for gas, and as a convenient method of enriching poor gas; but the mild weather of the past winter has not favoured the use or need of water gas, particularly in this district, where there is a ready market for coke, and where the transport of oil adds considerably to its cost.

Inclined retorts continue to make their way; and ere long we shall have several additional installations in the Midlands. An invitation to visit one or more of them may be anticipated by our Association. Charging, drawing, and their attendant coal breaking and conveying machinery, are also receiving a good share of attention; and several Midland works—my own being among the number—are being equipped in this way.

The advantages of machinery with horizontal retorts over inclined ones may be doubtful where entirely new works have to be constructed; but where horizontal settings are already in existence, to discard them in favour of inclined ones would involve expensive structural alterations, and the sacrifice of much costly brickwork. As yet, I have had no personal experience with machine charging; but I quite anticipate important advantages from its adoption—not the least being the simplification of labour, and the relieving of stokers of one of the most trying portions of their work.

With regard to gasholder construction, it does not appear that any new departure has to be chronicled. The enormously large structure erected by Mr. Livesey at the East Greenwich works is a record which, if equalled, is not likely to be exceeded. The tank and gasholder in course of construction at the Saltley Gas-Works (which, through the courtesy of Mr. Hack and his Committee, we were privileged to see something of at our last meeting) will, however, when completed, be the nearest approximation in size to those at East Greenwich, and the holder will be the second largest in the world.

Not the least gratifying feature in connection with the huge holder at Saltley, and the extensions that are being carried out therewith, is the irrefragable testimony borne to the growing character of our industry—and that in the presence of keen competition with its rival the electric light, supplied under municipal management, and probably under conditions most favourable to its extension. What is taking place in Birmingham in regard to gas-works extension, applies in a lesser measure to most of the manufacturing towns in the kingdom.

The chief cause of this growth doubtless is the extended use of prepayment meters. From experience, I can speak most

favourably of them. The Company I represent have about 1200 of them in use; and the number is increasing steadily. We commenced by putting in slot-meters in houses where gas-fittings were already fixed; but later a point was reached when it was considered desirable to supply fittings also free. This has been done. The fittings comprise a slide, a bracket, a boiling-burner, and the necessary piping, the rental of which is considered met in the charge of 1d. for each 25 cubic feet of gas supplied. There is, of course, a considerable amount of extra trouble entailed in working these meters; but the trouble is paid for in the increase of revenue from the sales of gas, and undoubtedly the system is appreciated by the industrial portion of the community, on whom it confers a larger measure of safety and comfort.

Perhaps the great novelty of the year in gas lighting was the new burner of the Welsbach Incandescent Gas-Light Company; and though it does not realize all that was promised on its behalf at its inception, it is a distinct improvement on the older form of bunsen burner, which it may eventually supersede. Of the improvement that has taken place in street lighting with incandescent burners, we have some excellent examples in the city in which we are assembled. New Street and streets in the neighbourhood of the Council House are most effectively lighted, and are well worth our notice at night time. Other cities and towns furnish similar examples of good street lighting.

The past year was marked by a further advance in the price of coal; but happily it has not adversely affected gas undertakings, as concurrently with the advance came an increase in the value of coke and sulphate of ammonia. How far the selling price of the latter has been influenced by the action of the Sulphate Makers' Association, it is difficult to say; but certainly the efforts made by the Association to bring prominently before the public the valuable properties of sulphate of ammonia are steps in the right direction, and must eventually benefit all gas undertakings. I am not now a maker of sulphate, but sell the ammonia liquor in a concentrated form, which admits of the recovery from it of cyanogen as well as ammonia in the form of sulphate. Whether, however, we work up our liquor or not, the selling price of sulphate is the factor which determines the value of the crude liquor; and the efforts made by the sulphate makers to bring into prominence the value of the article they produce are timely, and deserving of our hearty support.

When perusing the figures given in the analyses of accounts of gas undertakings given in the "Gas World Year Book," two

points specially interested me; and to these I wish briefly to cal your attention. The first is the amount of capital employed per ton of coal carbonized; and the other, the amount contributed in rates and taxes.

Where the undertakings are owned by municipalities, as might be expected, where not only a low rate of interest is paid, but the loans themselves are being wiped off by annual payments, a great difference is shown in the amount of capital employed. In one case, £1 10s. 11d. per ton is sufficient; while another undertaking employs £13 19s. 2d. It must be obvious that as both of these concerns belong to municipalities, either the selling price of gas or the profits made by the respective owners must be seriously disproportionate. The rate per cent. of interest for loans is probably much the same in both instances.

With respect to the gas companies given in the list, in one case £3 14s. 9d. per ton serves; while in another £12 9s. 9d. is employed. These are extreme instances; and a great difference exists in the magnitude of the works. But even in large concerns, wide variations are shown, amounting to about 100 per cent.

With regard to gas companies, is it not desirable that there should be a closer approximation than is here shown in the relative amounts of capital employed per ton of coal carbonized? The interests both of gas companies and their customers are promoted by low capital charges; and till this consummation is reached, no hard-and-fast lines should be drawn in determining what amount of a company's expenditure should be charged to revenue and capital respectively.

Low capital charges tend to secure the maintenance of good dividends and low-priced gas; but not infrequently money that is used under the sliding-scale clause in inflating good dividends and in reducing the selling price of gas in accordance with this clause, might be more judiciously employed in increasing the profit-earning power of the undertaking. Were more attention paid to these matters by those responsible for them, the great disparities I have spoken of would not exist, and our industry as administered by companies would be more strongly fortified against competition.

The second point of interest in the analyses I have spoken of deals with the amounts contributed in rates and taxes; and here, also, some striking differences are manifest. In one case a corporation gas undertaking pays 6½d. per ton of coal carbonized; while in another instance, also a corporation gas-works, 1s. 11d. is charged, though the rates per pound probably differ but slightly. In respect to works owned by companies, in one case

a payment of 8d. per ton suffices; another company pay 1s. 9d.; and a third 2s. 5½d. per ton.

These differences point to a serious defect in the methods pursued in assessing gas property. To determine what rent a hypothetical tenant should pay, is not an easy task at any time; but the difficulty is enormously increased when, as is sometimes the case, the valuer employed on behalf of the parochial authority is paid by a commission on all increases sustained on appeal to Assessment Committees or Quarter Sessions. Such appeals end not seldom in compromises, intended to appease the opposing litigants, but which leave the merits of the case still in obscurity. The ability of a company to pay is in the opinion of not a few people the measure of what they should be compelled to pay.

Were a principle adopted, applicable alike to all gas undertakings, of charging a fixed percentage on gross incomes, or a sum per million cubic feet of gas produced or per ton of coal carbonized, disputes would be far less frequent than they are, and much costly litigation would be avoided. Any one of the above data would form an easily ascertained basis to work upon, and one that might at any time be re-adjusted without producing friction between the parties interested. There is no reason why gas undertakings should not bear a full share of the rates and taxes of the country; but under existing conditions, and faulty methods of arriving at the amount, many bear more than their fair share. In some cases, there would still be an appropriateness in using the language of the petition published fifty years ago in the first number of the *Journal of Gas Lighting*, which said that "the present system of rating of gas-works is unequal, unjust, and oppressive."

The analyses of the accounts of the different gas undertakings which are presented to us from time to time, offer abundant food for reflection; and I know of no better method of discovering the strength or weakness of our separate concerns than by treating our accounts similarly, and making a comparison. This proceeding, when followed by the friendly interchange of ideas which this Association is established to afford (and which I believe it happily fulfils), will conduce to the good ordering and prosperity of the undertakings here represented.

In reference to the remarks in my address relating to regenerative furnaces, I should like to add that during the past winter some interesting experiments have been made by my friend Mr. Glover at the West Bromwich Gas-Works, with a view to increase the amount of coke available for sale. As most of you are aware,

previous to the introduction of regenerative furnaces in this district it was no uncommon thing to fire retort-settings with cheap coal slack or low-priced coal. The plan had all the defects of the direct-fired system—imperfect combustion, irregular heats, and large deposits of dust in the flues. The introduction, however, of regenerative furnaces necessitated the use of coke as fuel; and Mr. Glover has been experimenting with a view to return to the use of coal slack. He has designed a producer so constructed as to prevent the dust from passing into the retort-settings. Mr. Glover writes: "The working of the producer is simple and straightforward; and I have no difficulty in maintaining the retorts in two settings of 20 feet long at a high temperature, using 60 per cent. of small slack and 40 per cent. of coke. Complete combustion is effected by my method of introducing the gas and air to the setting; and the old difficulty of large dust deposits has been obviated. While I am satisfied that the system is a great advance on the old one of direct firing, I do not at present feel warranted in extending it. I give preference to regenerators fired with coke." Mr. Glover, I may say, has not thought the matter of sufficient importance to warrant his giving the Association a paper on it; but I am sure you will agree with me in regarding the experiment an interesting one, and the result of it worth communicating to the members. As has been frequently remarked, the record of a partial success, or even of a failure, is sometimes as instructive as that of an undisputed success.

Mr. LEWIS proposed a hearty vote of thanks to Mr. Reeves for his address.

Mr. PETER SIMPSON (Rugby) seconded the proposition; and it was carried unanimously.

The PRESIDENT, in acknowledging the vote, intimated that there was time for a discussion on some subject of common interest if any member would be kind enough to suggest a topic or open a discussion.

After a short interval,

Mr. HUNT asked if Mr. Glover would give the members some particulars on the subject of the special producer which he had designed for using coal slack as fuel.

Mr. GLOVER said he had not intended giving a paper or any detailed statement as to the construction and working of the producer referred to; but he had gladly supplied to the President a short account of the general results obtained. He might, however, say that it was the outcome of a desire to substitute a

cheaper form of fuel than coke for the heating of retorts. Coke just at that time was rather valuable; and if coal slack could be made to take its place without losing the advantages of the regenerative system of heating, a saving might be effected in the cost of fuel. To attempt to use for a trial the usual form of producer installed in a gas-works was quite out of the question, because of the difficulty of getting the air for primary combustion to pass through a mass of small and compact material. It was necessary, therefore, to have a forced draught; and, to facilitate the charging of the producer, to construct it well in front of the retort-settings to be heated. To prevent the nostrils in the setting from furring up with finely deposited carbon, due to tarry matters in the producer gas, the raw slack was subjected to a preliminary heating before it was allowed to drop into the active part of the producer, where the air and steam were decomposed. When the charging-door (which was flush with the retort-house floor) was removed, this preliminary carbonization of the coal slack might be seen going on. The quality of fuel he had in use was about 60 per cent. small slack and 20 per cent. coke. The use of a proportion of coke had been found almost necessary to keep the fuel open, and to make sufficient producer gas for the work to be done. He was not satisfied with the fuel account, but intended making some alterations in the hope of improving this. There would, however, always be a loss by radiation, as the producer was a steel-cased one, standing in front of the settings. There was another source of loss incident to the use of bituminous or semi-bituminous fuels, which would be understood by those who had studied the chemistry of the subject. It arose from the gas containing a larger proportion of hydrogen than producer gas made from coke. This necessitated a greater volume of oxygen for its combustion; and, of course, being accompanied by a much larger bulk of nitrogen, the absorption of heat by the secondary air must be considerable. Deposits of dust had been prevented from occurring about the retorts by making the gas-tunnels of ample size, so that the rate of flow was such as to enable the dust to deposit where it would not be felt. The heating of two 20-feet settings of eights had been perfect throughout the winter. He had come to the conclusion that, except under very exceptional circumstances, coke was the ideal fuel for heating gas-retorts when used in a well-constructed regenerative furnace. He would throw out one suggestion for the members to consider; and it was the possibility of primary air short-circuiting in the front of many furnaces or producers as

usually constructed. This was the cause, in his opinion, of settings heating up more readily on the side farthest from the furnace. The quality of producer gas from the back of the furnace was better—containing, as it did, a larger proportion of carbonic oxide—than that at the front. This was worth consideration, although he admitted that the furnaces or producers with which they were familiar worked very well with only a moderate consumption of fuel, and the regulation of the heat was not at all a difficult matter.

A brief conversational discussion followed, in which Mr. George Winstanley, Mr. R. O. Paterson, Mr. W. C. Jones, of Kingswinford, Mr. Percy H. Fletcher, of Evesham, and others, took part. The most important point referred to seemed to be as to the cause of different temperatures throughout the length of a 20-feet setting, and the best methods to be followed for overcoming the difficulty.

Mr. PATERSON subsequently asked if Mr. Glover could give the meeting any information as to the process of enrichment described in a paper read before the Institution of Gas Engineers last spring.

Mr. GLOVER said he might briefly remark that, so far as naphthalene deposits were concerned, after the plant was started in July last year, stoppages due to this cause had disappeared, after working for about six weeks. Considerable relief had been experienced when working in the way described; and cheap enrichment had been obtained by the process.

At the close of the proceedings, the members had tea together

SCOTTISH GAS MANAGERS.

ANNUAL MEETING, APRIL 5.

The Sixteenth Annual Informal Meeting of Gas Managers in Scotland was held at the North British Station Hotel, Glasgow. There was a larger attendance than usual. Mr. ALEX. YUILL, of Alloa, the Convener of the gathering, in whose hands all the arrangements had been placed, formally opened the proceedings at two o'clock, and moved that Mr. W. Ewing, of Hamilton, take the chair.

Mr. EWING at once did so, and proceeded to deliver the following address:—

Permit me to thank you sincerely for your courtesy in appointing me to the honourable post of President of this the Sixteenth Annual Informal Meeting of Scottish Gas Managers. I trust, should my efforts fall short of your expectations, that you will be "to my faults a little blind, and to my virtues very kind."

Gas manufacture remains very much as it was a year ago, there being no marked improvements to alter its general routine. The success of incandescent gas lighting still keeps electricity in the background as an economical light, although, more for the sake of being sole purveyors of light, corporations who are presently owners of gas-works will, sooner or later, have to supply the two illuminants, or allow a company to come in and supply electricity.

During the past few years, the gas managers of Scotland, by their economical methods of working, have enriched their respective towns—in some instances by many thousands of pounds—by the sweeping reductions that have been made in the charge for gas, and this in the face of an unprecedented drop in the price received for residuals. Take, for instance, the price of tar and liquor at Hamilton in 1892 at 9s. 11d. per 100 gallons mixed, and compare it with the present price of 2s. 6d. per 100 gallons, and take our last year's volume of tar and liquor, which shows a drop in revenue of quite £3000. For fully five years the gas consumers of Hamilton have paid 2s. 1d. per 1000 cubic feet for their gas, and no meter hire; the former price being 2s. 11d. and

a charge for meters. The total benefit to gas consumers during that time is £18,000, notwithstanding the fact that in 1892 there was a proposal to increase the price to meet the requirements. These figures do not represent the actual saving, as a comparison with the old and new methods of working shows that since 1892-3 the difference in volume of gas per ton of coal carbonized amounts to 96½ millions, which, taken at its selling price, is equal to £10,054; the increased volume of tar and liquor—825,000 gallons—taken at the average price, is £1856; and 10,000 tons of coke, £2375. There was also a proportionate saving of not less than £5000 in wages, in spite of the fact that the average wage per man is now 30s. per week, with a shorter day, against 25s. 6d. formerly. These figures represent a total of £37,285 in better working results during the six years; and without this improved working, the Corporation and gas consumers of Hamilton would have had to pay a very high figure for gas. There are other items, such as the saving of interest, &c., which would very considerably increase the above sum; but this is quite sufficient to show one of the many instances in Scotland whereby the combined energies of a gas manager, backed up by an intelligent, hard-working Convener and Gas Committee, have given to the gas consumers a large sum in hard cash, which seldom receives the consideration it merits.

Gas cookers and fires have been greatly in demand during the past year; the year's bill in Hamilton amounting to about £1000 (which includes the fixing) for some 352 different kinds of gas apparatus. We use what is termed the "Hamilton" cooker, with tiles on hot-plates, which are principally used for scone baking. One pleasing feature in this department is that all classes of gas consumers have taken a large interest in cooking by gas. The inducements given by the Gas Department are the fitting up of fires and cookers free of cost where not more than 30 feet of pipe are required, and a rental charge for cookers of only 5 per cent. on the cost. Where corporations have a large number of cookers in use, I think it would have a tendency to preserve them if several money prizes were given yearly for the best-kept cookers. We find, as a rule, that consumers take quite as much care of a cooker as a kitchen range; and I know of several cookers at present in use where the greatest amount of care is taken to keep them in a high state of efficiency. The penny-in-the-slot cooker has not yet been taken full advantage of in Scotland; and I think that, by offering a little more inducement to consumers, in the way of fitting up a bracket, meter, and cooker free of charge, there would be quite

a "boom" in both prepayment gas meters and cookers. This could be done without incurring much expense, and would be an advantage both to gas departments and a class of consumers who could only be reached in this fashion. We can take a lesson from our friends over the Border in this matter.

The present year will tell heavily on the finances of most Scotch gas-works, owing to the large increase in the price of coal, and the low returns from residuals. I anticipate that many gas-works will require to increase the selling price of gas. Recent coal contracts made by our Gas Department show an advance on local supplies of 43·75 per cent.; but with our usual working results, I am pleased to say that our present price, of 2s. 1d. per 1000 cubic feet, may remain the same, as an ample margin will be left to meet all requirements. To compensate for this large drop in the revenue, economy must be the order of the day; and with the exercise of this, backed up by the harmony between the Gas Committee, Manager, and employees which has always existed, there can be no doubt of the continued success of the Hamilton Gas Department, with hopes of a still further reduction in price.

The manufacture of sulphate of ammonia at gas-works is a source of profit, and prevents an individual company of tar distillers having the pull over certain districts, which I infer from the fact that last year we had only one offer in reply to our advertisement for the purchase of our tar and liquor. I would even suggest the distillation of tar at all works with a make of gas of over 40 million cubic feet, as the farther you go in tar distillation the more valuable it becomes. Since tar and liquor are profitable to the distiller, who pays heavy carriage in conveying it to his works, I would assume that a gas-works would profit largely in the saving of carriage alone on the manufactured article as compared with the raw material. Take, for instance, the probable amount of coal used at the Hamilton Gas-Works during the current year as 13,000 tons; and assume that 923,000 gallons of tar and liquor were made, 143,000 gallons of which would be tar, leaving 780,000 gallons of liquor at 4° Twaddel. It is understood that 3000 gallons of liquor of this strength make one ton of sulphate of ammonia; but by way of leaving a safe margin I shall take 3500 gallons, which would give 222 tons of sulphate of ammonia. The average price received per ton for sulphate during the past five years is £9 13s.; but take it at £9 10s., which leaves a margin of 3s. per ton, and gives the sum of £2109. Deduct from this £666, the cost of manufacture at £3 per ton (though Mr. Carr, of Widnes, by skilful manipulation,

has made sulphate at £1 18s. per ton), and there remains the sum of £1443 as the value of the manufactured article. In selling the 143,000 gallons of tar (the balance of product from 13,000 tons of coal) at the present market price of 9s. per 100 gallons, a sum of £643 10s. would be realized, which, added to the sum received for sulphate, represents a total of £2086 10s. We receive at present 2s. 6d. per 100 gallons for tar and liquor mixed. But, assuming that the 923,000 gallons were sold to the tar distiller in its raw state, at 3s. per 100 gallons, a sum of £1384 10s. would be realized; thus showing a balance in favour of sulphate manufacture at the gas-works of £702. Considering that the present price of sulphate is £10 10s. per ton, I think the above figures give a large margin of safety.

The emptying of spent liquor into the sewer system of a town seems to be objectionable to some people; but in my opinion it is an excellent disinfectant, and should not stand in the way of increasing the profits of a gas-works. Another source of increased profit in gas-works where there is head-room in coal stores, and where coal has to be carted into the works, is in the storing of coal from an inclined platform. Formerly at our works the price of storing and breaking cannel coal was fully 6d. per ton; but now, with a high level, it costs about 1½d. per ton, and about 1d. under favourable circumstances. There is also room for improvement in the manipulation of work and workmen in most retort-houses; it is there the profits of a gas-works can be made or lost. If we can make 9000 or 10,000 cubic feet per mouthpiece, why cannot that rate be kept up? The reason is the want of skilled supervision, as I always find that stokers endeavour to carry out instructions when properly given; and I am fortunate in having an excellent staff in my retort-house. At times one does meet a few whose efforts are to get done with their work as easily as possible; and these kind of men cost gas-works throughout the country many thousands of pounds per annum. But, again, a skilled superintendent should be able to keep such a schemer in his place; failing which, he is better outside. The following are a few tricks that are played by a scheming stoker, which tell heavily on the working results: He will carefully select damp coal, if it can be had, charge his retorts 3 inches deep at the back and 12 inches at the mouthpiece. The latter will be carefully filled with perhaps three shovelfuls of coal. He will charge a retort without delay, with perhaps four dull spots, instead of closing the mouthpiece door to bring up an equal heat before charging. He will sometimes leave his producer empty; and in shaking the bars he will purposely

forget to force down clinker from the top door of the producer, leave the bottom and top doors of the producer partly open, and then will say his setting has low heats. This kind of thing is only too common in gas-works; but it should not be tolerated for a moment. It is my opinion that, with careful stoking, many gas-works at present making about 6000 cubic feet per mouthpiece could get at least 9000 cubic feet; thereby saving 50 per cent. in labour, with an increased yield of gas and large saving in fuel. The index of our station-meter is taken hourly, so that any defect in production can at once be attended to.

Sunday labour in gas-works is often a bone of contention; and if I could find it suitable to partly do away with it, I would gladly recommend that it should be done. Perhaps those who have tried it may give us some information as to whether or not they find inconvenience from leaking retorts, low heats, &c. Gas consumption in many places is now nearly continuous throughout the 24 hours; and I find that with 10-light meters a revolution is often made between the surveys. I would therefore give a hint to meter makers on the necessity of adding a fourth dial. From my experience, even 5-light meters should have an additional dial. We sometimes judge the quality of gas supplied to a town by what we see at railway stations; but my experience teaches me not to malign a gas manager from what we find there, as I have yet to see a properly lighted railway station. The burners used are of the ordinary type; and as a rule are only changed when completely done. If railway companies would only attend properly to this department, and use regulator burners, a large saving of gas would be effected and better light given.

Should you find food for a good discussion in the foregoing remarks, any little effort I have put forth will be amply rewarded in gaining further information on the subjects mentioned.

Discussion.

Mr. H. POOLEY (Dunfermline) said that, ever since they had adopted the system of supplying gas-stoves, they had fitted up the stoves, brackets, and meters entirely free of charge. They found that it paid them, though not to the same extent as they would like. He thought that the practice in Scotland was to almost entirely use the griller; therefore, perhaps, it might be advantageous to give up the cooker and supply a good griller instead. Certainly, it would be a great deal cheaper. They fitted up ordinary stoves entirely free, irrespective of the length of piping, and supplied gas for them at 7d. per 1000 cubic feet cheaper than for lighting; and they did not charge any meter

hire for stoves. Their capital charges represented 1s. 9d. per 1000 cubic feet, which was within 4d. of Mr. Ewing's selling price; and this rather heavily handicapped them.

Mr. A. WADDELL (Broughty Ferry) agreed with Mr. Ewing—and he thought it would be the experience of all those present—that the public very seldom thanked a gas manager for anything he might do. In his own case, the price of gas had been reduced from 4s. 10d. to 2s. 11d. per 1000 cubic feet. At the place where he was previously, it was reduced from 7s. 6d. to 4s. 2d.; and he said there did not appear to be any disposition on the part of the public to say that anything had been done for their benefit, but rather that they were paying about the same price as before. He was sure managers were all feeling this year the increase in the price of coal, with the low returns they were getting for residuals. Capital charges in Broughty Ferry represented about 1s. per 1000 cubic feet; so that they were pretty well handicapped. But, like Mr. Ewing, he thought that, notwithstanding all these things, he should be able to pull through at the same price.

Mr. J. W. CARMICHAEL (Barrhead) remarked that he had been very pleased indeed to listen to the address. Mr. Ewing was the envy of most gas managers, on account of the price at which he could sell his gas. Of course, he was very favourably situated, being in the centre of the coal district, which helped him very much. The hiring out of stoves and prepayment meters was, he thought, a very good thing for increasing the sale of gas. It enabled them, as Mr. Ewing said, to be generous to their consumers, and to do what they could to help them. The manufacture of sulphate of ammonia was brought up at last year's meeting, and was threshed out pretty well. He had then very great trouble in following particular gentlemen, simply because those who gave their opinions were mostly at sixes-and-sevens on the subject. It was a difficult thing for many managers to know whether they should go in for the manufacture of sulphate or not. His own opinion was that where they had an output of from 20 to 30 million cubic feet, they could work a sulphate plant to advantage.

Mr. W. SMITH (Ayr) said he had listened with pleasure to the Chairman's address. In the matter of stoves, he found, from experience, that it would be far the better way to sell them entirely to consumers, making the price as low as possible. He hired stoves as well. In putting in stoves, he always saw to there being a sufficient supply of gas, because he found that complaints very often arose on account of an ordinary plumber

having been employed, who had just taken the gas supply from the nearest available source. He preferred to give an independent supply, passing through an independent meter; and consumers liked this too, because it let them know what gas they were consuming.

Mr. R. S. CARLOW (Arbroath) remarked that last year he put in about 400 prepayment meters; and this year there would be about another 400. He expected to have an increased output of gas at the end of May next of over 6 million cubic feet. This was owing to prepayment meters; and they would understand that it was a source of profit which they had not before. It must be remembered, too, that all the expenses—the burdens, cost of management, and everything else—were the same. He therefore looked forward to having a balance this year which would be very satisfactory indeed. In the matter of gas-stoves, he did not, like Mr. Ewing, give pipes and fittings free; but he charged exactly cost price, and the usual rent for the meters. The consumption of gas in stoves was another source of revenue to managers; and it was a business which they should push. They knew his opinion about sulphate of ammonia. The difference in the price could be easily accounted for. When he put up his works, prices were very low indeed; but immediately thereafter chemical prices went up, and the price rose to the tar distiller, who had not erected the works. Therefore the Arbroath Corporation obtained a good price after putting up their works. Comparing present prices for tar and liquor with those given by tar distillers in the district, and considering the quantities of sulphate of ammonia, naphtha, and boiled tar made, he found that, at the very least, they had £500 clear profit—that was taking into account the price of tar and liquor mixed He had no hesitation in saying that he did not for a single moment regret the step he had taken. So long as he was getting his present return, he was perfectly satisfied.

Mr. A. WADDELL (Broughty Ferry) said he was sorry to find that Mr. Carlow's introduction of residuals plant had not raised their price for his tar and liquor. Indeed, for five years their receipts from this source were 3s. 2d. per ton of coal carbonized. During the past year they had only obtained 1s. 10d.; so that they had not realized what Mr. Carlow indicated. He should have been very pleased to have had the profits Mr. Carlow spoke of; but with regard to the introduction of plant for working up residuals, he must say that their site was very small. It took them all their time to make what gas they required, without introducing other plant. Another reason against it was that

they were surrounded on all hands by a class of houses the occupiers of which would certainly not permit anything being done which they might consider objectionable.

Mr. CARLOW: I do not think that can be any reason at all, because my works are right opposite the Episcopal Church.

Mr. WADDELL: It is not exactly what is your knowledge; it is what people round about you think.

Mr. W. HAMILTON (Kilsyth) said he thought he heard the Chairman say he gave his stokers 30s. a week.

The CHAIRMAN: That is the average for the workmen. Our leading stokers get 38s. 6d.; and others receive 36s. 9d. and 35s. The lowest wage for stokers is 35s. They work seven shifts of eight hours each.

Mr. HAMILTON said he had always heard that money was made or lost in the retort-house. Would it not be better to give to the stokers the money which was made? His were small works; and he paid his stokers 30s. per week. They ought to pay the men the money, and not give it to the landlords by putting in pipes for them. In Hamilton, they had the lowest price in Scotland. Well, let them make the stokers the highest paid in Scotland.

The CHAIRMAN said that this was the case already. He paid the best wages to stokers that were paid in any gas-works in Scotland.

Mr. FORBES WADDELL (Forfar) said he had listened with a good deal of envy, and also with a good deal of pleasure, to Mr. Ewing's address—envy that he should not have been able to make such savings. Mr. Ewing had surely had some very bad stokers. He would not like to say that any stokers of his charged retorts 3 inches at the back and 12 inches at the front, though he agreed that if such men existed they would be better outside the works, or never should have been in them. He was perfectly satisfied that Mr. Carlow had not in the least exaggerated his profits from sulphate; and he thought it would pay himself very well indeed to have a sulphate plant, even if he only realized half the profit Mr. Carlow did. But, unfortunately, he had to say, with his brother, that he had not experienced the benefit Mr. Carlow was inclined to think they had on account of Arbroath having gone in for sulphate manufacture. The year before Mr. Carlow adopted it they were getting for tar and liquor 2s. 7d. per ton of coal carbonized. Last year, when they took in offers, with sulphate of ammonia at something like £7 10s. per ton, they were offered for tar and liquor 1s. 5d. per ton of coal carbonized. Thinking this not enough, they delayed;

and, though sulphate had risen to £9 10s. per ton, they only obtained 1s. 7d. He had not heard of anyone in the district benefiting in the slightest from Mr. Carlow's having taken up sulphate manufacture; and, consequently, he thought everyone should go in for it himself.

Mr. W. HAMILTON: What do you obtain per 100 gallons? That is the best way to calculate it.

Mr. WADDELL: We had alternative offers; but the contractor had apparently based both offers on the return per ton of coal carbonized.

Mr. T. D. HALL (Montrose) thought it would be beyond him to add anything new to the discussion. He had listened with much pleasure to Mr. Ewing's address. He could not exactly follow the figures given; but from what he was able to gather, Mr. Ewing seemed to show a very rosy side of affairs indeed; and he hoped that Mr. Ewing was appreciated for his efforts, and for the work he had done in increasing the consumption of gas. He had not had any experience of serving a corporation, but knew what it was to be under a company; and though the directors might appreciate a manager's efforts, the consumers as a rule did not, either in his reducing the price of gas or in his taking off meter-rents or fixing stoves. In fact, his experience had been that if a company felt themselves in a position to reduce the price of gas (say) 5d. per 1000 cubic feet, all the thanks they got in return was that the consumer would turn round and remark that the reduction ought to have been 10d. In his small way, he had done nothing in the matter of stoves, except in advising which would be the best stove, or fire, or gas supply, to introduce, in seeing that the house was properly fitted up, in supervising the plumbing work, and in selling the article at net price to the consumer. He must endorse the statement made by one or two of his neighbours, with regard to sulphate of ammonia—that since Mr. Carlow had introduced sulphate plant in Arbroath they had not found that they could get more for their tar and liquor than they obtained previously. They sold their liquor at so much per ton of coal carbonized, which, he thought, was the simplest way. As regarded Sunday labour, many years ago he read a paper before the North British Association on the subject of the cessation of Sunday work, which he advocated. But in those days they worked twelve-hour shifts; and he now thought that if stokers worked eight-hour shifts the stopping of work on Sunday was quite unnecessary. At the same time, when he used to stop the works for twelve hours—from six on Sunday morning till six at night, he

did not find the retorts or the heats suffered in the slightest. Of course, if they found they could miss a charge during the week, they would never think of working right through on Sunday, and lying off on Monday. They made a calculation to see how much spare holder room they would have on Monday, and if they found that they could save a run, they always did it on Sunday.

Mr. W. B. M'Lusky (Selkirk) pointed out that at Galashiels there had been no stoking on Sundays for thirty-five years, and it had been a very prosperous undertaking. It would appear, therefore, that the cessation of labour on Sundays was perfectly practicable. For his own part, since he had had the management of gas-works, he had never charged on a Sunday at all, and he got fairly good results. His method was to fill the retorts at four o'clock on Sunday morning, and start charging again at six o'clock at night. They never had any smoke at the chimney-head. Of course, the settings were regenerative, and he had complete control over the primary and the secondary air, which had a good deal to do with the success of the system. Mr. Ewing disposed of his liquor at 4° Twaddel, for 2s. 6d. per 100 gallons. He considered it was a mistake to allow liquor to leave the works at this strength, as they were simply sending away an agent which was valuable for purifying the gas and improving the strength of the liquor, on account of its properties for the absorption of carbonic acid and other impurities. He preferred to sell liquor at 8° Twaddel; and in this way he got a better price for it. In Selkirk, he could not sell over 5°; but they were taking steps to provide a machine by which to properly concentrate the liquor before letting it go to the distiller. With regard to the suggestion that there was a "ring" in Scotland to keep down the price of liquor, he might say that when he found he could not get a suitable price in Scotland, he sent it to the North of England. Of course, his position was between the North of England and the West of Scotland—about seventy miles from each; and he thought it would pay anyone in the West of Scotland, who was only getting 2s. 6d. per 100 gallons, to send liquor to the North of England, especially if it were concentrated to 8° Twaddel.

Mr. J. Napier Myers (Saltcoats) said he also had listened to the address with some degree of envy. The matter he was most interested to hear about was the prepayment meter. The desirability of "booming" that apparatus had been spoken of. This had not been his attitude at all. He had looked upon the meter not altogether with satisfaction. He had endeavoured to

give it a bad character, as he had only supplied it to bad payers. When he put in a slot meter, it was evidence of the difficulty of obtaining payment of some account. In Saltcoats they had gas in every house. They often had not very large accounts, because, being a coast town, they had 300 or 400 houses shut up in the winter time. In the winter, he had had no accounts in for as many as 400 out of 1800 meters. It had been remarked to him that those letting houses were desirable for prepayment meters; but he had at times experienced difficulty in putting these meters into such houses. When they went wrong, some trouble was entailed in finding out who had damaged them. It had been his experience that the roasting part of stoves was employed perhaps only once for every twenty times that the top-plate of the stove was used; and his attitude upon this subject had been that, while it was incumbent upon them to educate their consumers in the use of gas for other purposes than lighting, they were not called upon to go very largely into the gas-cooking business. Still they had already done something. They had let out grillers. They fixed them, and they charged the very modest rent of 1d. a month—1s. per annum. His experience was that a very serviceable griller could be supplied and fixed at a charge of 10s. From this very small apparatus he was able to get a good return. In his town, the houses were mostly small; and the larger ones were not often used for letting purposes. He had thought it his duty to advise his Directors not to go into stove-hiring, as it was no part of their business to deal in ironmongery. It had been their practice, during the past five or six years, perhaps longer, not to work on Sundays; but labour did not wholly cease. They charged the retorts in the morning, till breakfast time; and from then until nightfall it had been their practice not to make any gas. He held that gas-works which could not lie off at least from eight to twelve hours on a Sunday, were not equal to their work, satisfactorily, during the rest of the week.

Mr. D. VASS (Edinburgh) said that in his district of Portobello there were many letting houses. They began some years ago, when the undertaking belonged to a Company, supplying prepayment meters; and they had applications for them chiefly for these houses. The reason for this was that they held the yearly tenant of the house responsible for all the gas consumed, even though there might have been half-a-dozen tenants—some of them staying a fortnight, others a month, and so on. He read the meter, but held the householder responsible for the gas consumed. Sometimes, in this way, the householder was left with

the bill to pay; for occasionally a person would go away without paying the rent or the gas bill. Prepayment meters were tried as an experiment. They had, of course, the difficulty to contend with that when a meter went wrong they did not know who to blame for it; but they held to their rule that the yearly tenant was responsible. Doing so, they had never had any difficulty in recovering. There was another difficulty, in that one person might know how to work a prepayment meter, but another might not; and thus they might have to go to a house half-a-dozen times in the summer. Still, he thought it was very desirable to have prepayment meters in houses which were let in summer time. It was more, perhaps, a consumers' than a gas managers' question; but the body supplying the gas were interested in serving their consumers in the best way they could. Of course, they charged an extra price for the gas, to cover the additional expense—say, about 1s. per 1000 cubic feet.

Mr. J. B. TERRACE (Brechin) said that he sympathized with Mr. Ewing in his remarks about electric light coming into all their towns by-and-bye. His town and Montrose were to be the foremost of the small places to be tried with it. He did not take a very despondent view of the matter. On the contrary, he did not think that they would be much harmed by it—for some time to come, at any rate. There could be no doubt that when coal rose to them from 34 per cent. upwards, it would do the same to manufacturers of electricity. He had heard that, in some small places, shopkeepers used electric light only on Friday and Saturday nights; but that the arrangement was found to be unsatisfactory, and they soon got tired of it. Goods did not look the same in the different lights. He did not think that the higher price of coal was likely to lead to the raising of the price of gas; they would have to make up for the extra charge in some other way. He tried prepayment meters, in a small way, and with great success. He always endeavoured to encourage those who burned oil to take them; but if people who had an ordinary meter wanted a prepayment one, he tried to reason with them, and to show them how much cheaper it was to have an ordinary meter. They both sold gas-cookers at cost price and hired them; and they had done very well. In regard to sulphate of ammonia, his works were, like those of some of his friends, not situated in a good place for its manufacture, being surrounded by houses.

Mr. A. P. MAIN (Glasgow) wished to say a word about the lighting of railway stations, to which the Chairman had referred. One of the most interesting installations of gas lighting in recent

times was, he thought, that of the Great Central Railway Station in London. He went to see it about ten days before; and it was very interesting. Not only the platforms, but all the waiting-rooms and booking-offices, were lighted by gas; and the total cost for one hour's lighting of the whole had been ascertained to be only 2s. 6d. The lighting was by incandescent burners; and there was a special pressure of 9 inches, produced by means of a simple jet of water.

Mr. FORBES WADDELL said that a partner in one of the largest factories in Forfar, in which electric light was used, told him that in addition to the electricity costing them a good deal more than gas, they had to incur an expenditure of £300 a year to heat up the factory to the temperature required for the working of the material. This was unnecessary when the factory was lighted by gas.

Mr. J. M'GILCHRIST (Dumbarton thought it very creditable of Mr. Ewing to come forward and give them all the results of his own experience, so that they could discuss them. It was not every gas manager who could do this, and it was not every gas manager who could put such good material before them. Mr. Ewing talked of thousands of increase in a year as if they were penny-in-the-slot meters. He had obtained £6000 a year clear gain, on the basis he had laid down, which entitled him to rank as one of the first engineers of the day. With regard to the fitting up of gas-stoves, he thought they were departing altogether from their business of gas manufacturers when they took up the position which had always hitherto been occupied by the landlord of the property. He understood that if they put a gas-pipe into a house, it at once became the property of the landlord. He thought that the furthest they should go in this direction was simply to hire out. But, in the next place, there was not such a great profit to be derived from stoves. He rather thought, with Mr. Myers, that the working-class population particularly would derive much greater benefit from the use of grillers. Mr. Ewing had spoken of the people south of the Border being able to teach them a lesson in this matter; but they knew that the workpeople in "puir auld Scotland" had roasts much more seldom than they had in the south. Again, he thought that the prepayment meter had not been the great success in Scotland that it had been in England. Speaking of the towns he knew, single-apartment houses in Scotland were fitted up for gas lighting; whereas there were villas in England in which there never was a gas supply until penny-in-the-slot meters were introduced. In Scotland, there-

fore, there was not the same ground to cover. The question of working up sulphate was discussed at last year's meeting; and he thought there had been no change since then. Mr. Ewing's recommendation to work up the tar products was, he thought, altogether in the wrong direction. He held that they should be gas manufacturers, and not sulphate of ammonia makers or tar distillers. A manager, even in the smallest gas-works, had plenty to do if he paid attention to the economical production of gas, and the pushing of the sale of it. His chief reason for saying this was that in the great corporations in Scotland where there were tar-works, these were found to be a great loss, even where they were in a position to employ their own chemist to work them. In Glasgow, they were very keen business men. They had tar and liquor works there; but they found it cheaper to let them to a tar distiller. The man who had been brought up to the business knew best how to handle the works. Mr. Carlow was not quite so proud of the position he took up last year. He said he did not regret having put up sulphate plant; but perhaps if Mr. Carlow had to do it again he might not.

Mr. CARLOW: I would do it to-morrow.

Mr. M'GILCHRIST did not know how the gentlemen from the North took up the position that the adoption of sulphate manufacture in Arbroath should raise their prices. He rather thought they had been too severe on this point. With regard to oil, it was the case that its adoption had reduced the price of coal. Perhaps sulphate was in the same position. He hoped all those who had oil plants would continue to work them, because he thought that if they did so, they might secure cheaper coal. He did not know where they were to find men to occupy the position of gas managers if they were to tack on to their duties not only the business of wholesale ironmongers and gas-fitters, but also that of tar and liquor distillers. He did not know why it was that the producers of electric light had rushed away to the North when they had much better fields in the South. Did the managers in those towns not think that if they reduced the price of gas for lighting, instead of for cooking, they would better keep out the electric light? If the electricians were to come to Dumbarton, he would be glad that they should take up the lighting of the streets, which was what they were certainly best at, and which, he thought, was no source of profit at all to the gas maker.

Mr. A. YOUNG (Alloa) had no doubt that Mr. Ewing's results would act as an incentive to them to do all they possibly could in their own works. He himself had had experience both of

selling tar and liquor and of manufacturing sulphate of ammonia and distilling tar; and he could candidly say it was a source of profit to manufacture sulphate of ammonia. He would almost give it, at the lowest estimate, at 1d. per 1000 cubic feet of gas. If they took Mr. Carlow's figures for last year, they would find that the profit was $1\frac{6}{10}$d. per 1000 cubic feet. He could see perfectly well how it came about that Mr. Waddell received only 1s. 7d. for his tar and liquor, though the price of sulphate had risen to £9 10s. per ton. The price of naphthas and benzols to a large extent determined the price of tar; and tar was a considerable factor with distillers in the figure they gave for tar and liquor when sold combined. He did not think there could be any doubt at all but that if any manager wished to increase his profits, stoves and other gas appliances would materially aid him. His own experience, in leaving this matter alone, as Mr. Myers did, was that gas-fitters and ironmongers did nothing too. When the Commissioners took the matter up, the public had confidence in them, and they also took to it. His Commissioners had made application for a Provisional Order for the supply of electric light. They were contemplating putting the plant in the gas-works, so as to have the management of the two illuminants under one control. He had gone into some figures, to show the difference in cost between electric light and gas—more especially incandescent gas lighting. Suppose they took ten electric lamps of 16-candle power, these would give a light of 160 candles, and would require 600 watts of current, which, at 6d. per unit, would be equal to 3·6d. per hour for the ten lamps. Taking the newer forms of incandescent gas-burners, and assuming that they obtained 20 candles from 1 cubic foot of gas, a light of 160 candles would require 8 cubic feet of gas per hour, which was equal to 0·24d., or a little under a farthing, to give the same light. The question of electric motors for smal powers had been brought before them; and he had also made a calculation as to them. With gas, they could develop from 20 cubic feet 1-horse power per hour. For ten hours this would equal 200 cubic feet of gas—coming to 6d.—as the cost of a 10-horse power gas-engine for one hour. An electric motor would require 760 watts for 1-horse power per hour, or 7600 watts for ten hours, which, at 6d. per unit, would equal 3s. 9d. per hour. Taken altogether, he thought they had no reason to fear the incoming of electricity.

The CHAIRMAN, in closing the discussion, thanked them all sincerely for their remarks, and reviewed, in a judicial manner, the observations which had been made.

Mr. POOLEY proposed a vote of thanks to Mr. Ewing for presiding at a meeting which, he said, had been so enjoyable.

On the motion of Mr. M'GILCHRIST, Mr. Yuill was re-appointed Convener of the meeting.

Mr. YUILL proposed that Mr. J. W. Carmichael, of Barrhead, be Chairman at next year's meeting; and this was agreed to.

The customary dinner was afterwards held in the hotel—Mr. Ewing in the chair.

WAVERLEY ASSOCIATION.

HALF-YEARLY MEETING, APRIL 13.

The Seventy-sixth Half-Yearly Meeting of the Association was held in the Central Hotel, Princes Street, Edinburgh. Mr. JOHN M'LAREN, of Duns, presided over the largest meeting which has ever been held under the auspices of the Association. A number of visitors were present.

The HON. SECRETARY (Mr. W. B. M'Lusky, of Selkirk), in submitting the minutes of the previous meeting, said the funds of the Association continued in a satisfactory state.

The PRESIDENT expressed his pleasure at meeting so many members and friends of the Association. It had, he said, been his intention to make an address; but for one or two reasons he had refrained from doing so. In the first place, he did not expect he would be able to be present at the meeting, as he had had a bad attack of rheumatic fever, and had been confined to the house for two months. He had thus been unable to concentrate his thoughts on any subject. In the second place, he found, on looking over the programme, that there was so much to be done, that he questioned whether they could get through the business in the time at their disposal. He must, however, mention that, since they met in September last, they had lost by death another of the old members of the Waverley Association —Mr. Walter Hogg, late of Melrose; and he was sure that all the members and friends there would join him in expressing their sympathy with the relatives whom he had left behind to mourn his loss.

The HON. SECRETARY said he had received a communication, dated Oct. 10, 1898, from Mr. W. T. Dunn, the Secretary to the Incorporated Gas Institute, informing him that at a meeting of the Council of the Institute a resolution had been unanimously passed declaring it to be desirable that application should be made to the Board of Trade with the object of obtaining their recognition to a set of standard meter-unions in the United Kingdom; but that, before any action was taken, a circular should be issued to kindred institutions and associations, asking

for their views and observations on the matter. He had replied that the Waverley Association would not meet until April; but that, in the meantime, they would not stand in the way of any progress which the Institute might make in the matter.

The PRESIDENT said that the subject had been before several meetings of the Committee; and, speaking for himself, the standardizing of meter-unions would certainly be a great benefit, because, in a small place like Duns, he had most of the work to do himself.

Mr. R. S. CARLOW (Arbroath), having been called upon, said there had been several communications between The Gas Institute and the North British Association of Gas Managers; and, as there was to be a meeting between the Committees of these bodies in May, it would be as well to allow the matter to stand as it was.

Mr. D. VASS (Edinburgh) proposed, to keep the affair in order, the appointment of a Committee similar to that which they appointed last year, consisting of the President, Past-President, and Secretary, to take charge of the matter.

This was agreed to.

Mr. M'Lusky was unanimously elected President of the Association for the current year, and returned thanks.

Mr. A. C. Young (Kelso) was unanimously elected to perform the duties of Hon. Secretary during the year in which Mr. M'Lusky will occupy the presidency.

Mr. H. RUTHERFORD (Aberlady) then presented Mr. M'Laren with the President's Medal, and in doing so congratulated him on the very able way in which he had presided over their meetings.

The PRESIDENT suitably acknowledged the gift.

Discussion.

The PRESIDENT, introducing a general discussion, said that in Duns they had just held a very successful exhibition of cooking appliances—in fact, it far surpassed all that he had expected. During the first and second days they sold almost nothing; but on the third and fourth they sold sixteen cookers, in addition to small grills. They had sold about £100 worth in all. He expected that the fitting up would cost him a great deal of trouble; but he was quite willing to face it. They sold gas for heating at 4s. 6d., and for lighting at 5s. 10d. per 1000 cubic feet. They were fixing the cookers free. He thought that, taking the size of the place—their annual make was about 5 million cubic feet—they had done very well, and that it would pay them. He

expected next year they would have a make of between 6 and 7 million cubic feet.

Mr. W. BLAIR (Haddington) said that they went in for an exhibition last year. They had not exceeded Duns in the sale of cookers, grillers, and boiling-rings; but they had done fairly well. He was very pleased with the success they had had; for they had an increase of about 15 per cent. in the sale of gas. He would advise anyone who had not yet gone in for cookers to take the matter up. It seemed to be the only way in which, in small places, they could increase the sale of gas.

Mr. A. C. YOUNG (Kelso) said it seemed to him that in the Border towns they were in the happy position of having communities with money, because they appeared to prefer to buy cookers rather than to hire them. He offered them for sale or hire; and out of over £500 worth of cookers sent out, they had only about £40 worth on hire. He found that the griller was as good for the Gas Company as the cooker. In Kelso, they were over a million cubic feet up upon the previous year.

Mr. M'LUSKY remarked that in Selkirk they had finished their first year of hiring and selling cookers. In March, 1898, they had an exhibition extending over six days; and during this time they had purchases amounting to over £600. Since then they had expended between £700 and £800 on gas cooking appliances; so that they had placed an amount of over £1300 in cookers in one year. Though they had offered cookers freely on hire, the total net value of those hired was £44. Their cash charge for all cooking appliances was list price, less 20 per cent.; and they fixed all sorts free, with no limit as to length of pipe. The best class of people bought outright. If the list price of a cooker was £5, the purchaser would pay £4 down, and it cost them about £1 to fix it; so that they had an immediate return of £3. In this way, it paid both them and the consumer better than did hiring. They had about 500 different connections for cooking appliances; and during eleven months they had had an increased make of gas of 3,300,000 cubic feet—or equal to about 22 per cent. This increase was entirely attributable to the additional quantity of gas used for cooking and heating purposes, because their ordinary accounts had not increased. It had, of course, to be borne in mind that slot meters had been introduced. During the year, he had fitted 83 slot machines in connection with boiling-rings; and he thought that, in many instances, the boiling-ring brought as good a return as the big cooker. They had just made a rule that no new cookers would be hired so long as they had an old cooker in the show-room.

They could afford to do this, because they were really getting no cookers back.

Mr. Vass thought that the Border towns were very favourably situated as regarded cookers. The experience in most places was rather the other way. He found that people would rather hire than purchase smaller goods than they were allowed to put out. In Portobello they began, a long time ago, to hire out cookers; and they thought they had taken up all the business in the district. But last year, as soon as the Gas Commissioners entered into possession, and reduced the price of gas, the demand increased; and the number of cookers out had risen from 120 to 180. This was owing to their having had two exhibitions. One of the firms who exhibited had come back this year; and their return was within one or two cookers of what they placed last year—thus showing that there was still room for more business. There was one matter which gas managers would have before them very strongly for some little time—that was the question of street lighting. The tendency was to use the incandescent system; and he thought that what they ought to do was to follow up the electric light, and go in for large clusters of incandescent burners—reducing the number of lamps, and, by means of bye-passing, lowering the cost of lighting at the same time.

Mr. J. Black (North Berwick) stated that he had an exhibition of gas-cooking appliances last year, which was very successful. He thought his output would be up to 2 million cubic feet.

Mr. Young said that most of them who had read the report of Mr. Herring, of Edinburgh, would see that on the Continent the incandescent gas-lamp was putting the electric light out, except on the boulevards, not only on account of economy, but on the score of efficiency. In the same report, they also found that Liverpool was one of the best lighted cities; and Liverpool was lit almost entirely by incandescent gas-lamps.

Mr. M'Lusky said it might not be generally known that in the Border district a gas manager was put in gaol for touching a gas-lamp. In Selkirk there were forty incandescent gas-lamps, with No. 4 burners. These had been given to the town by the Gas Company, with the double object of lighting the streets well and making gas popular for other purposes. The Company were satisfied with the result, and they purposed introducing a few more lamps next year.

Mr. J. Napier Myers (Saltcoats) suggested the desirability of the members of the Waverley Association continuing their consideration of the subject of the standardizing of meter-unions, and strengthening the Committee which they had appointed.

It was quite possible that the predominant partner—their friends across the Border, whom they had sought to carry along with them in this matter—might not be so keen for reform as they were in Scotland; but this need not cause them in Scotland to hesitate in pressing on the reform. This experience in gas making had been fairly divided between England and Scotland. He was for some years Manager of two small places in the South of England—one in Somersetshire, the other in Devonshire. If he had continued in the district, he would probably not have been particularly anxious for reform in this matter, because the meters they used there were chiefly of London or Exeter manufacture. The meters were interchangeable in their unions, which was an advantage. On returning to Scotland, it was largely the finding of a different state of matters existing that induced him some years ago to move in the matter.

Mr. T. LIGHBODY (Renfrew) remarked, with reference to the subject of street lighting, that he fancied a good many managers were in a similar position to himself—he had nothing whatever to do with street lighting. He found that incandescent lighting in ordinary street-lamps was not good; the lanterns required to be specially constructed. Some weeks ago he saw in Manchester (which he considered to be the best-lighted town he knew) clusters of three burners, consuming 6 cubic feet per hour. The three burners were lighted till midnight, and then two were put out. Even with the burner that was left, the light was better than with an ordinary flat-flame burner.

Mr. BLAIR said that when they went across the Border, leaving behind them the miserable lights which were in Edinburgh, they began to see an illumination, because they consumed, in some places, 6 cubic feet per hour in each burner. In certain towns they had gas of 16-candle power, and in others of from 27 to 30 candle power; but, looking at them, the one seemed to be as good as the other. Of course, the former towns might be burning nearly twice the quantity of gas the latter were using.

The PRESIDENT said that in Duns the Gas Company fitted up two incandescent gas-burners at the works, to let the Town Commissioners see what the light was like. The Commissioners were pleased; and the Company agreed to light the Market Square with incandescent gas-lamps, on condition that the Commissioners would maintain the mantles. They would not; and there the matter ended.

This closed the meeting. The members and their friends, including ladies, were then entertained to dinner in the hotel by Messrs. Alder and Mackay. Mr. M'Lusky presided.

Presentation to Mr. Blair.

Mr. W. Blair, of Haddington, being about to leave the district for Helensburgh, was presented by his fellow-members and friends with a gold hunting watch for himself and a gold bangle for Mrs. Blair. The watch bears the inscription: "Waverley Association of Gas Managers. Presented to Mr. William Blair, Haddington, by members and friends, to mark their appreciation of his worth. Edinburgh, April 13th, 1899."

The presentation was made by Honorary Sheriff-Substitute J. C. Adamson, of Airdrie, who said he presumed it was out of respect to his early and long connection with the Waverley Association that he had been selected to make the presentation. If there was anything in the Evolution theory, Mr. Blair had a peculiar advantage as a man of light and leading. He was born and cradled and reared in a gas-works. His grandfather, his father, and four uncles were all in the gas line in Airdrie, Alexandria, Kilbarchan, and Girvan. He started work early—earlier, indeed, than the law would now permit. Commencing in the Johnstone Gas-Works as a message boy, he steadily worked his way up through all the grades of a provincial gas-works; looking after the water-traps, surveying meters, delivering accounts, laying mains and service-pipes, and finishing his career there by working for two years as a full-fledged stoker. Thereafter he engaged himself as an apprentice engineer with Messrs. Laidlaw, Sons, and Caine, with whom he gained some valuable experience in the construction and erection of the various engineering requirements in gas-manufacturing plant, in the erecting of which at the several works throughout the country he had frequently full charge. His first appointment as a Gas Manager was in 1883, with the East Wemyss and Buckhaven Gas Company, where he remained for about six-and-a-half years, when, on the resignation of Mr. Robb, he was appointed to the managership of the Haddington Gas-Works. During his ten years of office in Haddington, he had reduced the price of gas and remodelled and enlarged the works in all the manufacturing departments to double the capacity they had when he received his appointment; and the results he had been obtaining in his daily working compared most favourably with those at other works which they heard a great deal more about. Mr. Blair took with him to Helensburgh a matured experience in the practical and profitable management and development of a provincial gas-works; and those who had had an opportunity of observing his work in Haddington, would readily predict that he would produce equally good, or even better,

results in the larger works. But they all knew that, though good words might be worth much, they cost little; and his friends of the good old Waverley Association, who had known him longest and best, and who had appreciated his interest in, and contributions to, the various questions which had come before their meetings, desired to convey to him some more substantial token of their regard than mere words.

Mr. BLAIR briefly acknowledged the gifts.

Thereafter the company were, through the kindness of Messrs. Alder and Mackay, driven to their New Grange works, in the West-end of Edinburgh. They were conducted in parties through the works, and saw, among other novelties, a set of pressure-registers, with white metal fittings, enclosed in a very handsome mahogany case, which had been constructed for the Newcastle and Gateshead Gas Company. Re-entering the conveyances, the drive was continued to Roslin, where tea was served in the Royal Hotel. The company drove back to Edinburgh, and dispersed in Princes Street.

EASTERN COUNTIES ASSOCIATION

HALF-YEARLY MEETING, APRIL 19.

This Meeting was held at Cambridge, under the presidency of Mr. W. D. CHILD (Romford). There was an improved attendance of members; and a good programme was carried through in quite a vivacious manner. The members first met at "Ye Olde Castel Hotel," where light luncheon was served; and at two o'clock they assembled in the Council Chamber at the Guildhall for business purposes.

CONFIRMATION OF MINUTES.

The HON. SECRETARY (Mr. J. H. Troughton, of Newmarket) read the minutes of the meeting held at Romford on Sept. 15, 1898; and they were confirmed.

REPORT AND ACCOUNTS.

On the motion of Mr. J. CARTER (Lincoln), seconded by Mr. E. W. SMITH (Chelmsford), the report and accounts were taken as read. The number of members at the commencement of last year was 58, and 13 new ones were subsequently elected. The Committee regretted the loss, by death, of Mr. R. F. Paternoster, of Ipswich, three members resigned, and one had severed his connection with the Association under Rule 17. The total membership was 66. The accounts showed that a balance of £38 14s. 5d. was brought forward, and subscriptions paid during the year amounted to £35 14s.; making a total of £74 8s. 5d. The expenditure had been £36 3s. 2d., which left a balance in hand of £38 5s. 3d., and a few subscriptions outstanding.

NEW MEMBER.

On the proposition of Mr. TROUGHTON, seconded by Mr. H. WIMHURST (Sleaford), Mr. J. H. Duncan, of Melton Mowbray, was elected a member of the Association.

PAPERS AND DISCUSSION.

The PRESIDENT announced that Mr. A. L. Clarke, of Maldon, who had promised to read a paper on "Purification," had been

suffering from ill-health during the past three months; and at one time he (the President) quite expected the paper would have to be withdrawn. Mr. Clarke, however, had proceeded so far with it that he had consented to its being read by the Hon. Secretary. He was sorry they were deprived of Mr. Clarke's presence and assistance. This paper and the one to be read by Mr. Guyatt ran to a certain extent on such close lines that it would enable them to save time if they were both first read and then discussed together.

Mr. T. A. GUYATT (Ely) read his paper, which was entitled—

THE HYDRAULIC MAIN AND ITS FITTINGS.

It is not my intention to enter into the question of whether the hydraulic main is a necessity. In more than one works of considerable size I believe it has been abolished altogether; and many others have in use an anti-dip arrangement. I must, however, confess to a preference for the hydraulic and dip-pipe.

The primary object of the hydraulic main is, of course, to form a self-acting valve with the dip-pipes; but it also acts as a preliminary condenser and washer. It is now generally admitted that a tar-seal in the hydraulic injuriously affects the illuminating power of the gas; and various valves and overflow arrangements, more or less efficient, are in use, with the object of getting rid of the tar as it is made and maintaining a liquor seal.

The practice of having the hydraulic main in long lengths to take the dips from several beds is, in modern works, generally abandoned, and short lengths to take one or two settings are now used. This, with the modern practice of supporting the hydraulic independently of the brickwork, is more costly than the old plan; and some engineers consider that the advantages gained are not worth the extra capital outlay. It is obvious, however, that a long length of main, supported from the brickwork of the beds, must get considerably out of level, and consequently give very unequal seals. While all beds are at work, this is objectionable, but should one with a light seal be let down, it becomes a source of danger—serious explosions having occurred through the dips having become unsealed. It is, therefore, a very necessary precaution to carefully plug the dips of any bed not in use wherever more than one bed is connected to a length of hydraulic.

Some time ago I read an account of an elaborate arrangement of stirrers and agitators for removing the thick tar from the hydraulic. Such an arrangement could only have been devised

on the assumption that it is impossible to prevent the formation of thick tar in this position—a conclusion with which I am very far from agreeing. Formerly it was the universal practice to leave a considerable depth below the bottom of the dip-pipes; but years ago Mr. George Livesey proved that this was not necessary when he introduced the well-known form of "Livesey" hydraulic.

The form of tar-overflow described, and shown in the sketch, was arranged by Mr. C. C. Carpenter, and is used throughout the Vauxhall and Bankside works of the South Metropolitan Gas Company. During the time I was assistant to Mr. Carpenter, I had considerable experience of the advantages of this arrangement, and, therefore, decided to adopt it at my present works.

Briefly stated, the objects to be secured are to have the hydraulic supported independently of the brickwork of the beds, every dip sealed in an equal depth of liquor, and an overflow by which the tar is drawn off as soon as it is deposited. The first of these objects does not call for particular explanation; the method of supporting the hydraulic on girders carried by the buckstaves being well known.

In order to secure a perfectly level and equal seal for all the dips, they are turned in a lathe at each end to a gauged length; and a nick cut with the lathe tool to mark the depth of seal. The lengths of the dips under the flanges are kept approximately the same; but owing to the inequalities of the cover of the hydraulic, it is useless to be very particular about this. When putting the dips in place, the two end ones are first fixed, and levelled on top. The intermediate ones are then put in, and levelled to the end ones. Being all of a dead length, it follows that, by this means, the bottom ends of the dips inside the main will be perfectly level.

The tar-overflow consists of a cast-iron box bolted to the side of the hydraulic, with two holes communicating therewith; one at the bottom of the main to allow the escape of the tar, and another near the top to maintain equilibrium. A 2-inch overflow-pipe rises inside the box, with a running socket at the top to adjust the seal; and a plug at the top of the box gives access for the purpose of cleaning. It is desirable to have a small window on the side of the main to show the position of the tar and liquor.

Fig. 1 shows a section of a ⊐-shaped hydraulic main which I have had partly filled up with old bricks, floated off with cement, giving a cross fall of 3 inches towards the overflow. To adjust the seal, the hand-holes on the side of the main are left off, and liquor is run in, to the level of the nicks cut on the

dip-pipes, and the running socket on the outlet-pipe from the box is run down to this level. A liquor supply-pipe at each end of the main is provided for the purpose of flushing.

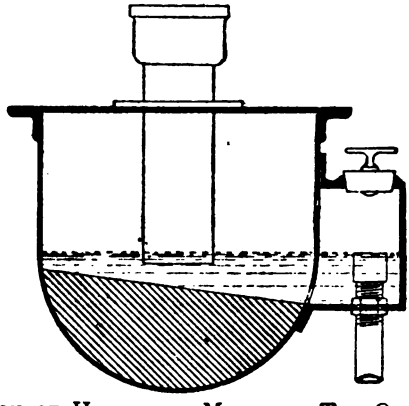

FIG. 1.—SECTION OF HYDRAULIC MAIN AND TAR OVERFLOW.

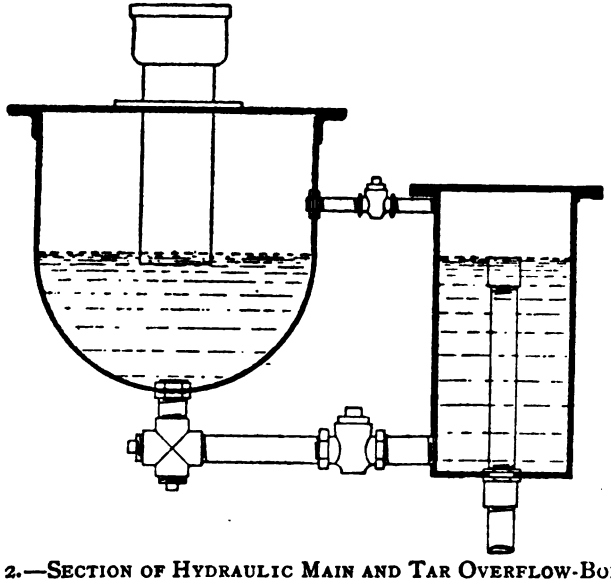

FIG. 2.—SECTION OF HYDRAULIC MAIN AND TAR OVERFLOW-BOX.

It is useless to pretend that this or any other form of overflow will work perfectly automatically for an indefinite period without attention. The tar-outlet between the main and the box requires

keeping clear with a small rake; and I have this done regularly every morning, and the main flushed through with Equor.

It is the general experience that, if there is serious trouble with stopped pipes, the hydraulic main is found to have an accumulation of thick tar in it; and in clearing the bridge and dip pipes a certain amount of obstruction removed from them falls into the hydraulic main—thus making matters worse, and eventually the main has to be cleared out, after which the pipes give practically no trouble for a few weeks. I therefore believe that the formation of thick tar and pitch in the hydraulic is generally a gradual process; and experience shows that the main can be kept clear of it by drawing off the tar at the bottom as it is made.

Doubtless many will recognize this arrangement of overflow as similar in principle to that shown in fig. 2, which is perfectly well known. The essential difference is in the length of the connecting passages, which are in this case only ¼ inch long—the thickness of the plate of the hydraulic. In dealing with such a material as tar flowing very slowly, this is an obvious advantage as tending to avoid stoppages in the connecting passages.

With regard to the depth under the bottom of the dips, a quarter of the diameter of the pipes will give the same area. Therefore, for a 5-inch pipe, 1¼ inches would theoretically be sufficient. I believe Mr. Carpenter allows only 2 inches, which is what I have adopted, and find amply sufficient. This allowance leaves practically no room for thick tar to accumulate, and the whole of the contents of the main are kept constantly agitated by the gas itself—the tar gravitating to the outlet communicating with the overflow-box.

One point which is sometimes overlooked is the necessity for having the hydraulic of ample area. The length is in most cases limited, but not the width; and I consider it a good plan to allow the gas plenty of freedom. It often happens that when a retort-house is being reconstructed, the engineer, in order to save expense, will endeavour to utilize what he can of the existing fittings. The modern tendency is to increase the number of retorts in a bed, and adopt regenerative firing. With direct-fired settings a make of 5000 cubic feet per mouthpiece is about an average yield; with regenerators 7000 to 8000 cubic feet, or more, may be obtained, and consequently a much larger quantity from the same retort-house. Under these circumstances, it is not surprising if the hydraulic main which worked well under the old arrangement should be found troublesome under the new, by reason of being overworked.

The distance which the hydraulic is raised above the beds

varies very considerably in different works. I do not think it any advantage to have it very high. In a well-ventilated house, 18 inches clear should be quite sufficient. If higher than this, it necessitates longer ascension-pipes which cannot be claimed to be advantageous.

The following remarks hardly come within the scope indicated by the title of the paper; but as the subject is closely connected with it, they may not be considered altogether out of place. The question has often occurred to me: "Are we using the most suitable material for our retorts?" The practice of using clay retorts is now so universal that at first sight the question may appear to hardly merit discussion. Fire-clay is, however, a very bad conductor of heat; and in order to get a temperature approaching 2000° Fahr. inside such a retort, a considerably greater temperature is necessary in the combustion-chamber. Cast-iron retorts were abandoned because they would not stand the higher heats which were gradually introduced. This was before gaseous firing was thought about. I do not advocate going back to the old cast-iron retorts, but suggest that, with a well-arranged gas-fired setting, the wear and tear is so materially reduced that it should be possible to produce a special cast-steel retort which would stand. The initial heat in the combustion chamber might be considerably lower by reason of the metal being a good heat conductor. In support of this, I may instance the Yeadon revolving retort. This has not yet proved a success; but I believe the failure has not been due to any difficulty with the retort itself, which was made of a special steel, and spanned a furnace, quite unsupported, for about 8 feet. If a revolving retort will stand under these conditions, should not a fixed retort, properly supported, be even more successful? I am inclined to believe that the question is worth experimenting on, and feel confident that, given the demand, metallurgists will be able to supply a durable retort.

The HON. SECRETARY next read Mr. Clarke's

NOTES ON PURIFICATION.

In the early stages of purification, which is always spoken of, and truly so, as commencing in the hydraulic main, some of the heavy tarry matter and aqueous vapour is deposited, and the cooling process is commenced. We may take it that the temperature of the gas on leaving the dip-pipes is from 120° to to 160° Fahr.; and it is absolutely necessary that, in order to keep the most valuable hydrocarbons in suspension, the cooling

process should be very gradual, or the illuminating power of the gas will be materially affected. In order that the cooling process may be gradual—first, the hydraulic main should be of ample size; and, secondly, the foul main should be, in the smallest works, not less than 6 inches. Yet in most gas-works of small capacity, we find ridiculously small hydraulic and foul mains; and the consequence is that the gas is subjected to a large amount of friction, and some of the most valuable hydrocarbons are deposited. I do not think that quite enough importance is attached to this portion of the plant from the point of view of effective purification. In my case, with a make of 17 millions, I have substituted a 10-inch for a 6-inch foul main; and I am sure that I get far more gradual and effective condensation than I did with the 6-inch. I believe that if more attention were paid to the gradual condensation of gas we should hear far less of the eternal naphthalene question.

We may take it that the chief impurities in the gas after it leaves the condenser are carbonic acid, sulphuretted hydrogen, ammonia, and bisulphide of carbon. Now the chief impurity that the washer has to remove is ammonia. As showing the value of efficient condensation, I may mention the fact that, at a temperature of 60° Fahr., with the barometer at 30 inches, water absorbs about 783 times its own volume of ammonia gas, and the lower the temperature of the gas the greater the proportion of ammoniacal gas absorbed; so that the colder the water in the washers the more effectively is gas purified from ammonia. Of course, there is a limit to this, as the illuminating power would be materially affected if the temperature of the gas were allowed to drop much below 50° Fahr.

Along with the ammonia likewise comes carbonic and hydrosulphuric acids; and although there is not sufficient ammonia to completely neutralize all the acid impurities, one wonders how long before we arrive at the theoretically simple process of adding sufficient alkaline matter to complete the neutralization of these acid impurities and thoroughly purify coal gas in closed vessels. Certainly in most gas-works the fact that gas contains enough alkaline matter to neutralize a large amount of its acid impurities is not sufficiently recognized. The liquor from the hydraulic main, for instance, has come in contact with the gas at such a temperature that a very small proportion of these acid impurities can be in combination with it; the temperature of the liquor there being (say) 150° or 160° Fahr., at which the combining power of the alkali is almost *nil*. If, therefore, the liquor from the hydraulic main and condenser is brought sufficiently

in contact with the foul gas, it is capable of absorbing a great deal more of the carbonic acid and sulphuretted hydrogen.

You will see from this that far more can be done in small and average-sized works in this direction than at present. In most small works, I believe hydraulic main ammonia is completely wasted. This brings me to another point I wish to particularly emphasize; and it is that by this means the quantity of fresh water used in the process of purification of gas may be very materially reduced, and the resultant liquor be stronger and smaller in bulk—a very necessary thing in small works.

In dealing with the last stage of purification by lime and oxide of iron, I will first state the system we have at our own works, which is to place a good layer of lime at the top of each purifier, and three layers of oxide of iron underneath in each purifier. Then, as each clean purifier is put to work, it is made the last of the series. We are compelled, in some measure, to follow this course, as we have a Weck centre-valve, and can only work the purifiers by rotation. But I think the system has its advantages, because we to some extent remove the sulphur compounds. In the President's address at Romford last autumn, he stated that he performed his dry purification with "alternate layers of lime and oxide of iron; the boxes being worked on the rotary system." Now, I cannot see that, from a chemical point of view, there is any advantage in the system of alternate layers of lime and oxide. On the contrary—and I speak with all deference—it seems to me, rather, to be wasteful of lime, although, in practice, I have no doubt Mr. Child gets better results than I do. It would, at any rate, be instructive to me if he would give his reasons for such an arrangement.

In a system such as I have previously named, the actions and reactions would be as follows—viz., the sulphuretted hydrogen of the foul gas on entering the first purifier combines with the oxide of iron to form ferric and ferrous sulphide, and with the lime to form sulphide of lime, while the carbonic acid of the gas passes over the oxide and is absorbed by the lime, forming carbonate of lime. Carbonic acid being a stronger acid than sulphuretted hydrogen, the sulphide of calcium is decomposed, and the carbonic acid passes on to the next purifier. In this way the lime in each purifier is converted into sulphide of calcium in turn, and is then in a fit state to take up the bisulphide of carbon. So that, as this is done at a small cost, purification from the sulphur compounds is within the reach of small works, and is a better system, in my estimation, than simply finishing up with a lime purifier.

In conclusion, I cannot help mentioning how much I agree with the President's remark as to the necessity for a gas engineer to have a good knowledge of chemistry. How much more interesting his work becomes when he understands, if only to a small extent, the marvellous actions and reactions going on hourly under his control.

Discussion.

The PRESIDENT said he did not rise to formally propose a vote of thanks to the authors of the papers; but he wished to thank them personally for having come forward with two such contributions for the meeting. They were sure to give rise to a good discussion, and would be very useful to the members. He thought papers of this description were just what were wanted for the District Associations. Papers which introduced absolutely new methods and ideas—such as that which Mr. Shadbolt brought before the Association some time since, on the "Self-Enrichment of Gas"—should, it seemed to him, be taken to such a body as The Gas Institute, where they would receive the consideration and discussion which such original ideas deserved. But details of construction and manufacture, and even commercial methods, were what they could discuss at District Associations with advantage to everyone attending the meetings.

Mr. R. G. SHADBOLT (Grantham) said he was extremely obliged to the President for the kind reference he had made to a previous effort of his in the way of a paper. With regard to future efforts, however, he presumed a paper containing original ideas would not be acceptable to the Eastern Counties Association; but if it consisted of ordinary detail it would be. [The PRESIDENT: No, no; it would be extremely acceptable.] On the subjects before the meeting, he did not think he had much to say, because he found himself somewhat at a disadvantage in not having had the papers before coming to the meeting. This was a very bad arrangement; and he certainly thought it might be improved. He considered that the Eastern Counties Association, though not the largest in point of numbers, might lead the way in this respect in the future, and let the members have the papers a day or two before the meetings. In the case of the paper by Mr. Guyatt, he felt there were a good many things in it which he would like to have thought over before venturing an opinion. Although they might only be matters of detail, they were details of great importance. Mr. Guyatt said that in more than one works of considerable size he believed the hydraulic main had been abolished altogether; but he (Mr. Shadbolt) did not think there were many in which this had been done. The

most successful case on record in dispensing with the hydraulic main had been in connection with the adoption of the steam-jet exhauster, which, however, was not in universal use in this country. There were so many factors which brought about the oscillations in the pull upon the retorts, that he did not think the day had yet arrived, or that they had yet arrived at such a state of perfection in regard to the pull on the retorts, when they could do away with the hydraulic main. With respect to the effect of the tar-seal upon the illuminating power of the gas, some twelve months ago it fell to his lot to transfer from an old retort-house, which was direct fired, to a new one upon an up-to-date system; and they had substituted liquor-seals for tar-seals throughout. But it was not "all beer and skittles" turning over from tar-seals to liquor ones. To begin with, he had heard it suggested in a discussion at Manchester, that the pulsation of the exhauster might have something to do with stopped ascension-pipes; but this might be a far-fetched idea. He had heard it suggested too that the pull on the foul main was communicated to the ascension-pipes much more readily, and was more sensitive where they had only a water-seal than where they had a tar-seal. He believed there was something in this; and though he had never heard of it being demonstrated, he had thought a good deal about it. Further on in the paper, the writer said, respecting the tar-seal, that it was a very awkward thing where they had a hydraulic main in one length. He himself believed in having a hydraulic to each bed. But the fact of the matter was when they let a bed down with a tar-seal, the tar thickened as the bed cooled, and they got something tantamount to gutta-percha on the end of the dip-pipe. In the installation of retorts his predecessor had left him to work with, they had a tar-seal; but they never had a stopped ascension-pipe. They got a maximum of 5000 cubic feet of gas per mouth-piece with retorts 8 ft. by 18 in. by 15 in. inside; but they practically had no stopped pipes or liquor-seal from the time they were put in until they were let down. This was well worthy of consideration so far as difficulties were concerned. Still, the more they reduced the body of tar, lying thickening in the hydraulic main, or the quicker they removed it, the less likely was there to be cause of trouble when working with high heats. The author of the paper said: "I believe the formation of thick tar and pitch in the hydraulic is generally a gradual process; and experience shows that the main can be kept clear of it by drawing off the tar at the bottom as it is made." With regard to his own experience in the putting up of hydraulic mains quite

recently, he provided first of all for a bottom overflow; but on further consideration, and after consultation with those who had had greater experience than himself in these matters, he cut down the top fender, and let the liquor out first. He thought so long as he did not continue the tar-seal too long, and, through driving at high heats, getting it too thick, he would have equally good results both in economy of working and illuminating power by flushing occasionally, as he would do by running it off quite gradually as suggested. The latter part of the paper interested him very much—viz., that which referred to the Yeadon retort. He himself had had some time ago an idea of testing a steel retort to see what temperature it could be worked at; and he was on the point of trying it when he saw the Yeadon retort. The retort was first made of cast iron, and then a change was effected. It was formed in the first instance with blades inside; but when the change was made from cast iron to steel, the retort was made in the form of a corrugated body. A great many difficulties had to be overcome in the working of the retort; and he was afraid they would never achieve what was considered possible in the first instance. After the experiment with the steel retort had been going on a certain length of time, the make of gas gradually fell away until they could hardly get any; and when the thing was taken to pieces, and the body of the retort examined, it was discovered that oxidation had been going on to such an extent, although of cast steel, that the accumulation of deposit was such as to eventually span the space between the retort and the surrounding brickwork, and (the revolving of the retort continuing) holes were rubbed through it. So that, judging from this experience, they might expect just as much oxidation with steel retorts as they were accustomed to in the use of those made of iron. Regarding Mr. Clarke's paper, he could not help thinking there was a little inconsistency in it. The writer suggested that, if they had in view a gain of illuminating power, it behoved them to condense very gradually; but farther on he recommended them to use a direct rush of liquor to the hydraulic and foul mains, so that they might use the ammonia. He (Mr. Shadbolt) could not help wondering what effect this would have upon the illuminating power, drawing on the lines of his first argument. He was afraid that the condensation there would be very sudden indeed. Then the writer, he gathered, said that by adopting so many layers of oxide his carbonic acid gas was driven forward into the next purifier, and the sulphide of calcium was free to act upon the remaining sulphur compounds. Had he (Mr. Shadbolt) heard this aright?

If so, it was putting the cart before the horse. [The SECRETARY read the passage referred to.] That, said Mr. Shadbolt, must be a mistake on the part of the writer. The question of purification was discussed at the last November meeting of the Manchester Institution,* so that he would not enter fully into it again. It resolved itself into this: "How far shall I purify? Shall I be content with removing the sulphuretted hydrogen; or shall I go a step farther, and remove the carbonic acid; or a step farther, and bring my sulphur below the Gas Referees' limit of, say, 20 grains?" What they attempted to decide at the Manchester meeting was this: Did it pay? And they concluded that it did pay. By using a certain proportion of lime, they forfeited a certain volume of gas by removing the carbonic acid, but they put it on the other end by gaining in illuminating power, which paid them; a step farther, they removed the sulphur compounds, but at increased cost. However, in spite of this, one could not consider it sufficiently great to warrant the sending out of gas not thoroughly purified.

Mr. W. J. CARPENTER (Yarmouth) agreed with Mr. Guyatt in his preference for the hydraulic and dip-pipe. In the early part of his career, he (the speaker) had a great deal to do with anti-dips, Chandler's dip-pipes, and so on; and under general conditions, or some of the older conditions, where they did not get up to so great a temperature as now, they could use most of these things. Providing that their exhausting arrangements were fairly equal, they could use the anti-dip arrangement; but if they did that which they ought to do, in order to do away with the tarry deposit in the hydraulic main, they brought about that which they tried to avoid—they did not get a dip or a seal or anything of the kind, and, of course, with very high heats they found a lot of deposited carbon down these arrangements, and did not get anything to keep the gas from coming back from the exhauster. Under all the conditions, the hydraulic main was far preferable. He might say by the way that they had Livesey and Tanner dips in use at Great Yarmouth. As Mr. Guyatt said, unless these arrangements were looked after carefully they did not get a liquor-seal even with them; but if they were carefully attended to they did, with a greater make per mouthpiece, and not quite so much trouble. In their old system of retorts (as Mr. Shadbolt had remarked regarding his old settings) they had but little bother, but they did not produce so much gas per mouthpiece. But then the price of gas was certainly a little better than now.

* See "Reports of Gas Associations" for 1898, p. 392.

Consequently the gas was produced under easier conditions and the manager was not troubled so much. Going on to the paper by Mr. Clarke, he said gas managers ought to completely purify their gas in every instance. In his own case, they had made a big effort to have their system of purifiers arranged in such a manner that they could reduce their sulphur compounds at any rate to provincial limits. About 17 or 18 grains of sulphur was their maximum. If the gas was "purified" in such a way that it contained a great deal of certain matter, the difficulties of their distributing staff were greatly added to. One thing he had considerably profited by, and it was this: They looked very carefully to see that the quality of the purifying material was as it should be. At his own works, they had before now accepted material which, when examined, had been deficient in quality. This meant, if used, largely increased expenditure in labour and material through its inefficiency; and moreover in the depth of winter it was not always possible to change it for better material. With regard to lime, more particularly, he had found some of the greatest variations in quality—ranging from 30 to 90 per cent. With 90 per cent. efficiency, see, he remarked, what a difference it made, compared with material of only 30 per cent. efficiency, in the purification of the gas and the lime account.

Mr. W. J. BEST (St. Ives) said that his works had lately been remodelled; and they put in a new hydraulic main in sections. Speaking from an experience of seventeen years, he strongly objected to his dip-pipes being sealed in tar. He believed in them being in liquor; and, with good exhausters properly regulated, they could make better gas and have no trouble. For the purification of gas, lime was, in his opinion, the proper thing.

Mr. R. BROWN (Cambridge) said he was in the same position Mr. Shadbolt was when he went to Grantham—that was, at the works of which he had charge at present the benches were of five beds, with one length of hydraulic main. He thought himself that there was something in what Mr. Shadbolt said as to the tar-seal—that it was a very good thing in some cases. But in his opinion, it was because formerly they did not work at such high heats as they did now that they were using inclined retorts. But at the same time he did not think this had all to do with what Mr. Shadbolt said with regard to tar-seals. To his mind, it had more to do with what Mr. Guyatt dealt with later in the paper, where he stated that the hydraulic main was sometimes overworked. He (Mr. Brown) found with the old horizontal settings that they never had much trouble with stopped pipes; but

when they got on to inclined retorts, with the gas going up one ascension-pipe to one hydraulic main, they were soon troubled with stopped pipes. As Mr. Guyatt stated, with regenerative furnaces, some 8000 cubic feet of gas per mouthpiece were made, as against only 5000 cubic feet with the others. The trouble was certainly due more to the overworking of the hydraulic main than to anything else. He could not agree with Mr. Shadbolt that working with a tar-seal was much better than a liquor-seal; his own opinion being that it was the other way about. However much he (Mr. Brown) agreed with Mr. Guyatt in the early part of his paper, he could not agree with him in the latter portion. That was the most debatable part of the whole of his contribution. He could not at all see that any advantage would be gained by going back to retorts made of any other material than fire-clay. He could not think how it could be, or how they would be able to keep the regular heats they were getting at the present time. Regarding Mr. Clarke's paper, in purification they dealt chiefly with the sulphur compounds. When he was at Hastings with Mr. Botley, they were very successful in dealing with the sulphur compounds; and they worked in this way: They had first two purifiers charged with oxide of iron, followed by four lime purifiers, and then oxide of iron again. He was not able to do this at Cambridge at the present time, because the purifiers were not sufficient; but with the system at Hastings they reduced the sulphur compounds to 6 grains per 100 cubic feet of gas. This statement might be received by some present with incredulity; but it was borne out by the tests of the Gas Examiner.

Mr. SHADBOLT said, with reference to Mr. Brown's remark that he (the speaker) had given a verdict in favour of the tar-seal, he did not intend to convey any such opinion. He simply pointed out that it was not all benefit to transfer from a tar to a liquor seal.

Mr. J. BARTON (Peterborough) said he did not quite know what was meant by this liquor-seal and tar-seal. Was he to understand that in the main in the first illustration it was absolutely all liquor and no tar?

Mr. GUYATT: There is a little tar in the bottom, up to the level of the overflow.

Mr. BARTON said it must be a mixture of tar and liquor, because if the tar was allowed to remain in the hydraulic main, it became more or less thick. Some time ago, he, like Mr. Shadbolt, changed his system of hydraulic mains to the modern dip. Previously he had the hydraulic main for the full length of

the retort-bench, taking about five beds of retorts. He had this taken away, and had the main fixed in sections—each section taking a bed of retorts. The tar was run off from the bottom, and the gas from the top, and it took its own course. They used to flush out the mains occasionally—say, once in 48 hours; and in order to fill the hydraulic main, they pumped in ammoniacal liquor. This went on all right for some little time—at any rate, they had not much trouble with the hydraulics. But he began to have some difficulty with naphthalene on the works and in the district. Such a case he had never heard of before; and he could not quite make out the cause. Moreover, do what he might he could not keep up the illuminating power to the point at which he wanted it. He therefore decided to discontinue the flushing arrangement, and allow the hydraulic main to work the same as the old one did—the gas and the liquor running together; and the result was they had no further difficulty with the illuminating power, and there was no formation of naphthalene either on the works or in the streets. It therefore occurred to him that the flushing out of the hydraulic main with ammoniacal liquor was one of the causes of the formation of naphthalene. He had not been able to prove this exactly; but at any rate experience had told him it was so. Another thing, when they flushed out the mains, they had no end of trouble with stopped ascension-pipes; they had the greatest difficulty to keep them clear. In fact, it was hard work to make gas at all; the ascension-pipes were continually blocked with lampblack. But as soon as they discontinued the flushing, and the gas and liquor just ran away together from the sections, they got along very well indeed—the illuminating power was all right, they had fewer blocked pipes, and no trouble with naphthalene.

Mr. Frank Prentice (Ipswich) remarked that he never heard the words "stopped pipes" without trying to find some valuable "tips;" but what were valuable tips to one man were perfectly useless tips to another. He supposed no one would have the hardihood to say he had found a perfect cure for stopped pipes under all possible conditions. Mr. Guyatt's paper was certainly an interesting one. It seemed to him that, if the author's main sloped from the ends to the middle, he would run a better chance of getting off the thick tar. He imagined that the side box did not run the whole length of the main.

Mr. Guyatt: It is only 5 or 6 inches wide.

Mr. Prentice said he should imagine that, if high heats were used, either end of the main would get pitched up with tar, because

of the difficulty of its flowing along to the lowest point of the dip of the concrete bottom, or whatever it was made of. Then Mr. Guyatt said it had been the general experience that, if there was any serious trouble with stopped pipes, it was owing to the tar in the hydraulic main being thick. So far as his (Mr. Prentice's) experience went, this was not the reason at all. There were a number of mains in Ipswich now, and very good mains indeed, which were perfectly thin, and had been like oil all the winter. He did not think there was an inch of tar in any of them; and they had had more trouble with stopped pipes in the previous fortnight than he remembered during the last ten or fifteen years. He used to think that, if a main was in a perfectly liquid state at the dead-ends, there would be no stopped pipes; but he was reluctantly compelled to say this idea had been completely shattered, like many other hopeful ideas he had possessed in connection with the subject of stopped pipes. Then, again, with regard to the plan of running out the mains, this had been tried at Ipswich very religiously—sometimes as often as twice a day; the idea being to take out a little of the thick tar every day, so as to remove any quantity that would tend to choke up the dip-pipes. But this had not been successful. When the mains were run out, they had to be filled up with something; and probably cold water was used. This tended to set the tar more than anything. With systematic running out every week or two, he found the hydraulic mains stopped up with thick tar, which could not be removed without taking off the ends or the top, which was a difficult proceeding in the winter. The last method they had adopted to keep the mains clear was one which was not perhaps new; but it was an idea of Mr. Jolliffe's, which he found successful. By having a main large enough, and far enough off the stack so that there was no additional heating beyond that given by the gas, and by ventilating the house well both ends and at the sides, the main was kept at such a temperature that it would not get thick. For some reason on certain mornings, a main would have a liquid-seal perhaps, and it would remain so for a week. One side of the house would have liquid-seals, and in a week every one of these seals would be tar ones; while on the other side of the house where there had been tar-seals, they would be liquid ones. He believed the reason was purely a question of temperature. He would advise anyone who was going to put in a new hydraulic main to have it amply large. On the question of purification, Mr. Shadbolt said they were asking themselves how far they should purify. Unfortunately this question

was settled for most of them—there was no choice at all in the matter; they were compelled to do certain things. At Ipswich they were in the tender hands of an Inspector, who was constantly testing against them for illuminating power, and frequently for sulphur and sulphuretted hydrogen. Therefore they could not very well say how much purification work they could do; but they had to do it pretty regularly and constantly, and had to be continually on guard against getting caught. Mr. Clarke's paper was interesting in a way; but he could not follow the arrangement he adopted—especially with reference to the mixing of the lime and oxide in the same purifier. From the paper, he gathered that Mr. Child did the same thing. If lime got mixed with the oxide ever so little, it spoilt the oxide, and the lime too; and if the lime was put in the same purifier, it must get tremendously mixed up after the oxide had been used once or twice, so that it would become practically useless. It was not very clear that this was what Mr. Clarke meant; and he (Mr. Prentice) was in just the same fog as Mr. Shadbolt and many others as to the chemical combination which took place, and which enabled him to make his purification complete. He had hoped to hear something on the question of the revivification of oxide *in situ* by air, because this was a matter which he thought would bear a little bit of talking about; and he did think there was a point there which might be taken up by a man who had time and opportunity, and which might yield some good results. The admission of air in the right quantity and at the right place must make the oxide last very much longer; but further than that, the point he wished to throw out was this: Supposing they could revivify the oxide of iron *in situ*, thus producing a considerable quantity of sulphur in the oxide, he had strong reasons to believe, although he had no definite figures, that free sulphur in the oxide affected the sulphur compounds, and reduced them. He was subject to correction, and also to any other ideas that somebody else might have on the question. However, this was the line he felt inclined to make a few experiments on himself; but whether or not they would produce any good, he did not know.

Mr. G. H. DUNCAN (Melton Mowbray) said as to the point of area in regard to volume, some few years ago it fell to his lot to manage a very small works; and before Mr. Ewing, of Hamilton, rebuilt them, the area of the hydraulic main was so small that it would not take the make of five retorts. But when the area of the main was increased; and its height above the bench raised, they had less trouble and fewer stoppages, which proved

conclusively that, as the volume of gas was, so the area of the main must be. Mr. Guyatt had well brought out what seemed to him to be almost like a copy of Hislop's tar-overflow; the principle was identically the same. A great factor in the dip was to have the flow of the liquor and tar almost equal, because if they allowed too big a tar seal, the illuminating power was injuriously affected. If they flushed out the mains, and set the exhauster to a certain point, or stopped it altogether for an hour or so, this had a tendency to regulate the illuminating power. He had found it to be so. In one works with which he was acquainted, the manager always ran water into the mains at the temperature of the retort-house. Regarding Mr. Clarke's paper, one speaker had alluded, with a little scepticism, to the use of lime and oxide in one box. At Portobello and Musselburgh, this system had been in operation for some years. At the latter place, they used the oxide in conjunction with lime. The gas first passed through a layer of lime, and then two layers of oxide. Between the lime and oxide a piece of coarse Hessian cloth was placed; and this prevented the oxide passing through. In conclusion, he asked whether it was a usual practice to pass the gas and the tar together, and what took place after it left the hydraulic. Was it the usual course of procedure for gas managers in this district to pass the gas from the hydraulic main through the scrubber before the condenser?

Mr. R. M. COUPER (late of Newbury) said that he had adopted the plan of having a hydraulic main over each bed. It struck him when he was putting the mains up that he had made a mistake; but before thinking of this, he had ordered the plant. In erecting the hydraulic mains, he thought how foolish it was to have 6-inch ascension-pipes, and yet only a 4-inch outlet from the hydraulic. He was then afraid of the result; but, in experience, he found no difficulty whatever in having a 4-inch outlet from the hydraulic. For four years, with good high heats, but only direct firing, they had no occasion whatever to take off the cover of the ascension-pipes to remove stoppages. This he thought was a point which might be interesting to some of the members who were so very much troubled with high heats. He worked with only a bare ½-inch seal on the hydraulics; and the tar and gas flowed away together through the 4-inch outlet. He had been especially struck with the paper on purification, and the references to the use of layers of lime and oxide in the same boxes. It certainly appeared to him to be a very difficult way of purifying. Personally, he would much rather stick to the use of lime in one purifier and the oxide in another, and have an

ample system of purification, than run the risk of having the oxide spoilt by admixture with the lime.

The PRESIDENT said that, dropping his eye down a few notes he had made, it fell upon the two words "How much?" This conveyed a great deal to all of them as engineers; and the whole question really was how much they ought reasonably to spend to get a proper return for their money by sending out a properly made article. With respect to the question of the hydraulic main, Mr. Guyatt had advocated—receiving general support—the advisability of having a liquor-seal in preference to a tar-seal. For about 25 years he (the President) had been working without either; and he was pleased to say he had done so. He believed he had been less troubled with stopped ascension-pipes than any man in that assemblage. He did not ask them to believe this was due to anti-dips. He stated the facts; and the members might draw their own conclusions. He had used Midland coal, also Durham coal; and there was little difference whether they were using one or the other. This he simply stated as an experience to show they must not say that the fact of a pipe being sealed in tar or liquor was the cause of stopped ascension-pipes. He himself preferred passing the gas away over the liquor rather than washing it in the liquor. Whatever means were adopted, the liquor must be tarry. The tar and liquor were formed together, and condensed from the gas; and they could not be separated immediately. Regarding Mr. Clarke's paper, the author alluded to his (the President's) address which he delivered at the previous meeting, and the methods therein described as being in use at Romford. He had referred in his address to the works at Romford because the members were visiting them, and not because he wished them to think he was putting them forward as being absolutely model works. He had no doubt they had all experienced the little difficulty of first convincing themselves, and then convincing their Directors, that they had better throw away a lot of plant which had performed useful work, and put in something which was thought to be a little better. Although he had recently built a new works, it was in many senses a question of removal rather than of absolutely new construction. It was his duty to make the most of the site, and to do so in the most economical manner possible by utilizing as much of the old plant as he believed would be commercially useful in the manufacture of gas. In setting up these new works, he endeavoured to arrange his plans so that he could obtain from them what he believed would be the best results under the circumstances. Mr. Clarke had spoken of the question of purification by oxide

and lime; but he did not look at the description of the first processes of purification. These consisted mainly of washing, in which he (the President) was a great believer. A weak ammoniacal liquor was pumped over the scrubber and from thence flowed into the first washer, so that they were washing the first crude gas with a strong ammoniacal liquor. In this way, they removed a large proportion of the carbonic acid and some of the sulphur compounds. The carbonic acid especially, which would have to be dealt with by the lime, was dealt with in this way. In order to remove the ammonia, he washed the gas again with pure water, and then passed it on to the dry process of purification; and in this way he had only a small amount of the carbonic acid which was originally in the gas to deal with. He always put the material in the purifiers in alternate layers—2 feet of lime in the bottom, and 2 feet of oxide of iron on the top. They might just as well work with deep layers as cutting them up into frivolous layers of 4 or 5 inches; and the thicker ones were really much better to work with. The little question of back-pressure did not occur. The lime being used for a long length of time, and becoming thoroughly carbonated, if it was put in the boxes in a proper way in the first instance, it could be cleared out without admixture. In this way, they effected exactly the same purpose as Mr. Clarke had in view—converting the lime in the first place into sulphide of calcium, because if they got rid of the greater portion of the carbonic acid in the washers and scrubbers, they had very little except sulphuretted hydrogen passing forward to be dealt with by the dry purifiers. Supposing they were starting *de novo* with the lime, and it was then converted into sulphide of calcium, and the remainder went over to be dealt with by the oxide of iron, by running the boxes in rotation, in course of time the lime became thoroughly satisfied with the amount of sulphur it could take up; and the small proportion of carbonic acid which was still passing on from the washers and the scrubbers displaced the sulphur, and took it through or into the next lime layer in the following box. The lime became thoroughly carbonated; and therefore he did not consider it was wasted. He liked to use a large proportion of lime, because he believed in the thorough removal of carbonic acid from the gas. They were not only benefiting the consumer but themselves. He would put the matter in this way: He had for the past three years been able to manufacture and send out 15-candle gas without any admixture of cannel or other enriching material. This he mainly attributed to the removal of the carbonic acid from the gas. He thought it right to make these

remarks, because Mr. Clarke alluded so pointedly to the process described in his (the President's) address.

Mr. GUYATT, replying to the discussion, said he had been much gratified with it. It seemed to be the general opinion that a liquor-seal was preferable to a tar-seal. No doubt, as Mr. Shadbolt said, the tar thickened in the main, and so blocked the dip, and prevented the drawing in of air there. But the modern tendency was to abolish the tar-seal. There was no doubt that the gas, in passing through the tar-seal, lost some of its illuminating power. With reference to the steel revolving retort, Mr. Shadbolt said that difficulties had been experienced owing to the corrugations getting rubbed away; but with a fixed retort this would not occur. He had not himself made any experiments on the point, and had merely thrown it out as a suggestion. He was very pleased to hear what Mr. Shadbolt said about thorough purification, as they had just decided at Ely to go in for sulphur purification, or to take out the rough of the sulphur. Mr. Carpenter agreed with his (Mr. Guyatt's) preference for the dip rather than the anti-dip or other arrangements of the kind; and he was very pleased to hear this. With the old system of direct firing, of course the tar-seal worked fairly well; but could they say the same working with the high heats now in vogue? He believed it was a general experience that there was bother with stopped pipes when working with a tar-seal and the high heats of regenerative settings. Mr. Barton spoke about his trouble with naphthalene and the formation of lampblack. Of course, the latter was really illuminating power he was losing; and he took it Mr. Barton was running cold liquor into the main.

Mr. BARTON: Not exactly cold.

Mr. GUYATT. It would not be heated to any extent, I take it.

Mr. BARTON: No.

Mr. GUYATT: If you heat the liquor, you lose the ammonia; and if you run cold liquor in, it would tend no doubt to the formation of naphthalene—it would reduce the temperature there.

Mr. BARTON: It was pumped back as it was made.

Mr. GUYATT (continuing) said Mr. Prentice seemed to fear they would be bothered with tar at the end of the main with the arrangement described. The box was simply a very narrow one in the centre. Mr. Prentice also appeared to think they had a mass slipping from the ends to the centre; but, as a matter of fact, they had never had any difficulty with the ends choking up. The 3-inch cross-fall threw the whole of the tar to the lower portion of the lower side of the main, and it flowed both ways; and, flushing it out every day, did not give it time to collect.

Mr. Prentice also spoke of the height of the hydraulic off the beds. He (Mr. Guyatt) learned from Mr. C. C. Carpenter the other day that he was now working with his hydraulic mains less than a foot above the beds; and he had had no difficulty whatever with stopped pipes working with this arrangement. Of course, he had the house well ventilated. Mr. Duncan had made allusion to Mr. Hislop's hydraulic overflow. His arrangement was very similar to Mr. Hislop's in principle, he believed; and there was a hood over the top by means of which the seal could be regulated. Mr. Duncan also asked about putting the scrubber before the condenser. Certainly it was not the usual practice to do so. There were cases where they had done away with the condenser, and pumped the gas direct into the washer; but he did not say he should like to do this himself. Mr. Couper spoke about having no difficulty with a 4-inch outlet from the hydraulic main. He (Mr. Guyatt) believed that, theoretically, a 2-inch pipe was amply large enough to carry away the whole of the make from the retorts; but, of course, they could not work this in practice—it would very soon get choked up. He could therefore quite understand that Mr. Couper would get the whole of his gas away with a 4-inch pipe. The ½-inch seal wanted looking after; but it could be made to work very well. With reference to the President's remarks as to capital outlay, and how much it was going to cost, that was a question connected with the designing of plant; but, of course, the plant should be kept within moderate dimensions by calculating the work that it was going to do. He might mention an instance of which he heard, of a large gas-works where they were actually reducing the size of their purifiers. They put down large purifiers to begin with; and now they were reducing the boxes to something like three-fourths of their area. It was the first instance he had heard of this being done. They could not work economically with the large boxes; and, therefore, they decided to reduce the area. He was interested to hear the President's remarks as to the use of thick layers of lime, and was pleased he had worked them so satisfactorily. There was no doubt a liquor-seal was not pure liquor; there must be a certain amount of tar with it. But when the tar was mixed with liquor, there was not so much resistance as with tar by itself. The gas had to force the seal in any case; and it would naturally go the shortest and easiest route. There was therefore no necessity for a great depth below the dip-pipes.

On the proposition of Mr. CARPENTER, seconded by Mr. BEST,

a hearty vote of thanks was passed to Messrs. Guyatt and Clarke for their interesting contributions.

Mr. GUYATT, in responding, remarked that this was the first occasion he had had the honour of reading a paper before the Association; and he was pleased with its reception.

ELECTION OF OFFICE-BEARERS.

The PRESIDENT said his next duty was to propose that Mr. H. Wimhurst, the Vice-President, be elected President for the ensuing year. For a long time from the beginning, Mr. Wimhurst acted as Secretary; and he laboured hard to pull the Association together, and to get it into proper working order. He was sure he would make a thoroughly good President.

Mr. C. W. GRIMWOOD (Sudbury) seconded the resolution, and heartily endorsed the remarks of the President.

The motion having been cordially agreed to,

Mr. WIMHURST, in response, said he felt that the honour the members had conferred upon him was more than he deserved. He certainly had had the welfare of the Association at heart from the commencement; and, with the support of the officers and members, he would do his utmost to further its interests during the coming year.

Mr. J. CARTER (Lincoln) moved the appointment as Vice-President of Mr. J. G. Hawkins (Spalding), who, he remarked, was as respected as he was well known.

Mr. GUYATT seconded the motion, and it was agreed to.

Mr. Troughton, whose admirable performance of his duties as Hon. Secretary and Treasurer was recognized by all the members, was re-elected; and Mr. Charles Ellis and Mr. C. Panchen were re-appointed as Auditors.

Mr. R. Brown, Mr. T. A. Guyatt, and Mr. E. W. Smith were elected members of the Committee—the last-named gentleman taking the place of Mr. Hawkins on his elevation to the vice-presidency.

THANKS TO THE OFFICERS.

Mr. J. T. JOLLIFFE (Ipswich) asked the members to accord a hearty vote of thanks to the President and the officers for the work they had done for the Association during the past year, The members knew that Mr. Child would fill the chair well; and he had answered their expectations. His presidential address was really a masterpiece of composition; and it contained many original and happy thoughts.

Mr. CARPENTER seconded the motion, which was unanimously carried.

The PRESIDENT, in acknowledging the vote, said he joined the Association, as he had done one or two others of a similar character, with the intention of working in it; and the members rewarded him by placing him at the head of it. He thanked the members for the way they had supported him during his year of office. He would take the opportunity of saying that everyone who joined the Association ought not to be content with merely being a member, but should strenuously attempt to do work in some way in its interests.

A vote of thanks was also passed to the Mayor and Corporation for kindly permitting the use of the Guildhall for the meeting.

NEW RULES AND AMENDMENTS.

The members next privately discussed, at considerable length, certain suggested alterations in, and extensions of, the rules, having for their object the admission of associate members. The first rule adopted (to be known as Rule 2A) described the necessary qualifications for membership in the new class. It reads: "That associate members shall be either secretaries or auditors not exclusively engaged in gas companies'-work, directors of gas undertakings, gas engineers, or such other gentlemen, who, by reason of their scientific or engineering knowledge, shall, in the opinion of the Committee, be likely to further the interests of the Association as set forth in Rule 3." Rule 13A confers on associate members "all the benefits of the Association, except voting upon any question." The annual subscription is to be the same as for members—viz., 10s. 6d. per annum. The new rules rendered necessary some minor amendments in other rules.

This concluded the business proceedings.

THE INCLINED RETORTS AT THE CAMBRIDGE GAS-WORKS.

Waiting outside the Guildhall were a number of brakes, which conveyed the members to the gas-works, where, by the kind permission of the Directors, they were afforded an opportunity of inspecting the installation of inclined retorts, which was erected by the New Conveyor Company. The retorts, which are 20 feet in length, are set six in a bed; and there are five beds. Splendid results are obtained, though a somewhat heavy charge—7½ cwt.—is used. The production of gas is 480,000 cubic feet per day; and the cost works out to 1s. 3d. per ton of coal carbonized from the coal-breaker out into the yard. It had been arranged that some of the retorts should be discharged on the arrival of the visitors; and, although they were about an hour behind the

appointed time, owing to the length of the proceedings at the meeting, they had the satisfaction of seeing that the delay had had no material effect on the free discharge of the retorts. The Engineer (Mr. R. Brown), with pardonable pride, directed attention to the excellent heats, and the evenness of the charges. Other parts of the works were also visited.

In the evening, the members and friends, together with a few local gentlemen, dined at "Ye Olde Castel Hotel."

NORTH OF ENGLAND ASSOCIATION.

HALF-YEARLY MEETING, APRIL 29.

This Meeting was held in the offices of the Newcastle and Gateshead Gas Company—Mr. CHARLES DRU DRURY, of Sunderland, the President, in the chair. There was a large attendance of members and friends.

ANNUAL ACCOUNTS.

The PRESIDENT submitted the accounts of the Association for the past year, showing a balance of £52 at the credit of the Association, and moved their approval.

Mr. J. HALL (Gateshead) seconded, and the motion was agreed to.

NEW MEMBERS AND ASSOCIATES.

The PRESIDENT moved the election of the following new members and associates:—

MEMBERS.

Mr. W. E. Sisson, Secretary of the Newbiggin-by-the-Sea Gas Company.

Mr. Joseph Chisholm, Working Manager of the Sacriston Gas-Works, near Durham.

Mr. Frederick Harle, Secretary of the Chester-le-Street Gas Company.

Mr. Frank P. Tarratt, Manager of the Darlington Gas-Works.

Mr. T. M. Waller, Secretary of the Durham City Gas Company.

Mr. T. H. Alderson, Manager of the Selby Gas-Works.

ASSOCIATES.

Mr. L. Taylor, of Dudley.

Mr. T. Duxbury, of Manchester.

The motion was seconded by Mr. W. DOIG GIBB, of Newcastle, and agreed to.

OBITUARY NOTICE.

The PRESIDENT said that the Association were in a very satisfactory position, so far as membership went; and they had had a good list of candidates just elected. But he regretted to have to refer to a rather long list of deaths which had occurred since

their last meeting. Death had made rather serious havoc among their numbers; no less than five members and associates having passed away. Mr. W. J. Mott, of Selby, who was only elected at the meeting last year, he was sorry to say, died in November. He believed that Mr. Mott would have been a most useful member of the Association; and it was sad to think that he had passed away in the prime of life, and in the midst of a busy career. Another gentleman who had passed away, of about the same age, was Mr. Robert Dale, of Durham. He also died in November last. Mr. John Henry Burn, a coal merchant of Newcastle, and an associate of the Association, was a gentleman no doubt very well known to many of those present. He died not long ago. He was, he believed, a most successful man of business, and a very kind-hearted man. The Association were certainly the losers by his death. Mr. John R. Foster was not one of their members at the time of his death, but he was formerly one. He was Resident Engineer of the Newcastle and Gateshead Water Company. He also died in November—in fact, November apparently was rather a fatal month, so far as the Association were concerned. Last of all was Mr. Robert Moodie, of Newcastle, who was known to all of them—a most genial man, a zealous servant of the Gas Company of the city (he believed he served for fifty years under them), and one whose friendly face would be missed at their meetings. He did not think this was the occasion for moving a formal vote of condolence—the time had passed by; still they felt the loss of the friends he had named.

Workmen's Compensation.

The Hon. Secretary (Mr. J. H. Penney, of South Shields) read the following report on the subject of the insurance of workmen under the Workmen's Compensation Act:—

At the last meeting of the Committee of this Association, it was suggested that I should see the Local Manager of the Company with whom we are insured under the Workmen's Compensation Act, with the view to obtain some abatement in the present rate of insurance, which it will be remembered is 9s. 6d. per £100 of wages. I subsequently had an interview with the Manager, and strongly pressed for a reduction. He promised to go into the matter at the head office. I received a letter in reply, in which he stated:—

I have gone very fully into the question of the risk of the Gas Companies insured with us through the North of England Gas Managers' Association. I am not, of course, at liberty to supply you with the exact and

detailed figures in connection with this subject; but I may tell you, speaking generally, that the experience up to the present time has not been a satisfactory one from our point of view, and that, as a matter of fact, if we have not actually lost money upon the business, we have barely been able to make the premiums cover the claims and expenses involved. I am afraid, therefore, it will be impossible for us to reduce the quotations given you last year; but we will extend them in this way—that upon a wage turn-over exceeding £400,000 per annum, we would be prepared to reduce our rate per cent. for the insurance of all Gas Companies coming to us through your Association to 7s. 6d. per cent. Our quotations therefore, for the next year, would read as follows:—

On wages not exceeding	£100,000	per annum	10s. 0d.	per cent.
,, ,,	150,000	,,	9s. 6d.	,,
,, ,,	200,000	,,	9s. 0d.	,,
,, ,,	300,000	,,	8s. 6d.	,,
,, ,,	400,000	,,	8s. 0d.	,,
On wages exceeding	400,000	,,	7s. 6d.	,,

I sincerely trust that the offer we are now making you, with the hope that next year's experience will prove somewhat more satisfactory than that through which we have just passed, will be thoroughly satisfactory to the members of your Association, and that they will make a strenuous effort not only to retain with us those Companies which have been insured with us through the medium of your Association during the past twelve months, but all the other Gas Companies that they have any influence with in the United Kingdom, in order that, if possible, we may obtain an aggregate wage turn-over exceeding the £400,000 per annum, in which case we should be prepared to grant the full insurance as in the past, at the rating of 7s. 6d. per cent.

It will be seen from the foregoing that there is no reduction in the present rate, but simply an extension of last year's sliding-scale, which was as follows:—

On wages not exceeding	£100,000	. .	10s. 6d.	per cent.
,, ,,	150,000	. .	9s. 6d.	,,
,, ,,	200,000	. .	9s. 0d.	,,
,, ,,	300,000	. .	8s. 6d.	,,
On wages exceeding	300,000	. .	8s. 0d.	,,

I regret that the Insurance Company have not seen their way to reduce the present rate. However, we have it in our power to reduce it ourselves through the medium of the extended sliding scale just quoted, if we can only induce the Gas Companies who are not yet covered to take out policies under our scheme. Any Gas Company can do so, and thus participate in the rate quoted to this Association, on communicating with us. Gas Companies who have not yet protected themselves, either by insurance or some equivalent, are running a considerable risk, as I am given to understand, on good authority, that there has been an increase

in the percentage of accidents since the Act came into force. At South Shields, we have recently had a case of total disablement. The injured man made a claim; and the Insurance Company have compromised the matter by the payment of substantial compensation. I have to express the hope that Gas Companies who have not yet insured, may be induced to take advantage of this scheme so that we may be able, in course of time, to participate in the lower premium provided by the sliding-scale.

Since writing the above, I have to add, by way of supplement, that I have been in further communication with the Manager of the Insurance Company, and he has agreed, I am pleased to say, to grant, in addition to the above-mentioned extension of the sliding-scale rate a certain conditional concession, which will be best explained by the following quotation from a further letter to hand:—

I am sorry that in my last I omitted to touch upon the suggestion of the 5 per cent. bonus which my Corporation are prepared to allow upon the next annual premium of all those policy holders who are members of your Association, and who are willing to renew their policies with us on the old scale of rating, as from May 1. This we are prepared to do on the understanding, of course, that in all cases where the bonus is applied for, the risk has proved a satisfactory and remunerative one during the past twelve months. Naturally, we should not undertake to allow these special bonuses in connection with such risks as have proved a loss to the Corporation, since we undertook their responsibilities last year.

This is practically an abatement of about 6d. in the premium of those Gas Companies who are in a position to take advantage of it. I trust that these concessions may be acceptable to those members of the Association and others who have induced their Companies to insure under the North of England scheme.

Mr. E. H. MILLARD (Durham) did not know whether the question was intended to be discussed at this time; but, in order to facilitate business, he would move that the subject be referred to the Committee for further consideration. He thought that everybody felt satisfied that the Committee had done their utmost in the interests of the members of the Association.

Mr. M. DUNN (Goole) seconded, and the motion was agreed to.

Mr. W. DOIG GIBB, of Newcastle, then read the following paper, entitled—

SOME SPECIAL FEATURES IN THE CONNECTING MAINS OF A PROVINCIAL GAS COMPANY'S STATIONS.

The district which the Newcastle-upon-Tyne and Gateshead Gas Company supply with gas under their parliamentary powers

measures about 92 square miles, of which 37 are north of the Tyne, and include Newcastle; the remainder, about 55 square miles, being south of the Tyne, and including Gateshead. The two works of the Company [see plate] are situated on the banks of the Tyne, on opposite sides of the river, and opposite each other, and on the west side of the principal area of consumption. The Newcastle works, with a productive capacity of 5½ million cubic feet per 24 hours, partly supply the North of Tyne district; the Gateshead works, with a productive capacity of 8½ millions, help to supply the North of Tyne district, and supply the whole of the South of Tyne district as well.

No room for extension exists at the Newcastle works; and in from one to two years from now the Gateshead works will be similarly situated. It has therefore been found necessary to provide a third site for a works; and for this purpose 68¼ acres of land have been purchased at the extreme east end of the North of Tyne district, and the erection of new works will be commenced there immediately. The position was chosen in consideration of the fact that Newcastle is extending most towards the east; and it was therefore desirable to improve the present distribution system as far as possible by introducing a new supply of gas into what are at present the extremities of the supply mains, and so feed the principal area of consumption from both ends. In pursuance of the same object, the future storage required for the extending Gateshead works is being provided for on the new site, by the erection there of a gasholder of 5½ million cubic feet capacity, which will be filled from the Gateshead works by suitable forcing machinery through the medium of a special high-pressure main.

For many years the two old works have been indirectly connected with one another. But in making arrangements for the inclusion of the new works, it was considered desirable to not only connect up the new works, but to improve the connection between the old, and at the same time to concentrate the principal governors and valves north of the Tyne in one house, for more complete control and supervision. This new governor-house is near the Newcastle works, and is therefore also on the west side of the principal area of consumption. When the new works commence to supply, the gas will be put into the distributing mains at the east side of the district as well, through suitable governors at or near the new works.

The purpose of the present paper is to note some special features in the connecting mains of the stations; and those stations, after the explanations already given, may be named as

the Newcastle works, the Gateshead works, the new works, and the North of Tyne governor-house. The absence of the South of Tyne governor-house is explained by the fact that the governing arrangements for this district are at present mostly controlled from the Gateshead works. The connecting mains are as follows: To North of Tyne governor-house there are two mains 27 inches in diameter from the Gateshead works, one main 30 inches in diameter from the Newcastle works, and one main 24 inches in diameter from the new works.

One of the mains from the Gateshead works is a high-pressure one; and connections and valves are so arranged that, if there be a necessity for it, all or any of the other supply mains can receive a high pressure from it. By other cross connections the three works are linked up without passing through the governor-house. High-pressure gas can also be supplied direct from the Gateshead works to either of the others. The two mains from the Gateshead works to the governor-house have each a length of 2380 yards. Most of the low-pressure main has been in existence for some time; and the proper completion of it presents no uncommon features—the difficulties experienced in keeping clear of drains and sewers, and of water, gas, telephone, and telegraph pipes being unfortunately the common experience in busy streets.

The high-pressure main, except a small part on the bridge across the Tyne, has just been laid. Gas is forced into this at the Gateshead works by twin gas-engines and exhausters, arranged to work singly or together. The gas-engines are each 25 nominal horse power, or 51 brake horse power. They are each fitted with two fly-wheels, and have a patent starter common to both, arranged below the upper floor. To ensure easy starting, and also to more properly drive the exhausters at the required speed, the power is transmitted from the engines to the exhausters through overhead counter-shafts, fitted with fast-and-loose pulleys. The exhausters are each capable of forcing 300,000 cubic feet of gas per hour against a pressure of 24 inches, when running at 55 revolutions per minute. A series of overhead girders carry the counter-shafts, and also the necessary water-tank for circulating water. The house and machinery stand on some filled-in ground. It was therefore necessary to make the foundations for these of a solid slab of concrete 47 feet by 43½ feet by 24 inches thick; and from this the walls of the house and special blocks for the machinery are carried solidly up to the required heights. The concrete floor is about 6 feet below the ground-level; while the working floor is about 1½ feet above. In the cellar thus formed between the floors are contained all the necessary pipe

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connections, patent starter, and meter. This latter has a dial on top which can be read by removing a small door in the upper floor.

When one engine only is supplying gas at moderately high pressure to the governor-house, it is necessary to ensure against a complete stoppage of supply. This has been done by inserting a balanced flap-valve connection between the inlet and outlet mains of the exhausters. The crank and balance-weight just keep the faced flap on its seat when both sides of the valve have an equal gas pressure. When the machinery is running, the flap will be held still more firmly closed by the pressure on the outlet side and the vacuum on the inlet side. But if the machinery were to stop through accident, the pressure on the outlet side of the valve would quickly fall below the holder pressure; and this latter, acting on the inlet side, would force the flap open, and so maintain in the pipe a pressure little (if at all) inferior to the holder pressure.

When both engines are supplying gas at high pressure to either the Newcastle works holders about 1½ miles away, or to the new works holders about 4 miles away, it may be convenient (even in these days of telephones and telegraphs) to stop the engines from whichever of the works is being supplied. For this purpose, the special automatic cut-off valve shown in the diagram (p. 110) has been designed. The gas supply to the engines goes through it, entering at the bottom of a small valve-chamber. The supply can be cut off there by a central dropping valve. This valve is carried by a vertical spindle, which runs through the top of the chamber, and is connected on to a cross straight lever; the latter being balanced so that the valve just closes when the lever is free to drop. On the top of the valve-chamber, but not connected with it, is another gas-chamber, the upper portion of which is formed of a pliable diaphragm. This diaphragm is connected by a short rod on its outer side to one end of a more or less right-angled lever, the other end of which engages with, and holds up, the cross lever supporting the gas-valve. The diaphragmed chamber is connected to the outlet side of the exhausters.

The method of working is as follows: When the engines are running, the gas-valve and cross lever are held up by the right-angled lever as long as the gas pressure on the diaphragm does not exceed a certain amount, as adjusted by balance-weights placed on top of it. But if any of the works being supplied find it necessary to close or partly close a valve on the high-pressure main, a revolution or two of the exhausters will increase the pressure in this; and the increased pressure, acting upon the

weighted diaphragm, will lift it, and so release the cross lever, which dropping will cut off the gas from the engines, and so stop the machinery. Some such arrangement as this is necessary, as the attendant who takes charge of this machinery will also have charge of the gasholder yard, and may be outside when

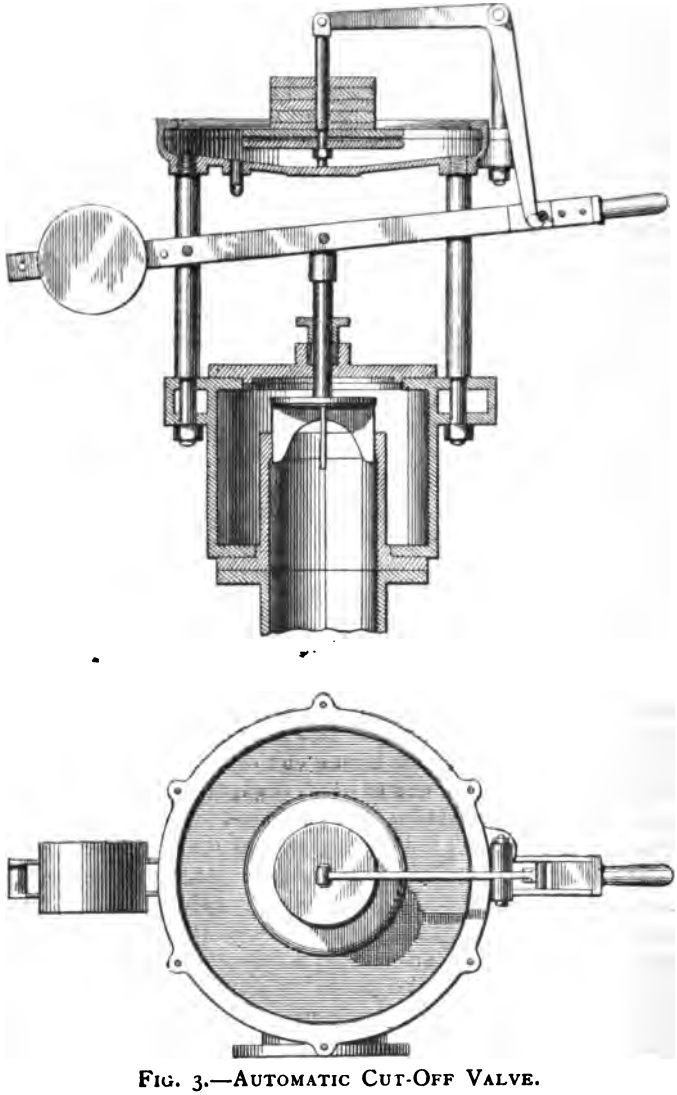


FIG. 3.—AUTOMATIC CUT-OFF VALVE.

the telephone rings; or, as it happens sometimes, the telephone may be out of order.

Gas is drawn by the exhausters from adjacent holders; and though the attendant will always be in more or less close proximity, it is proposed to avoid any risk of damage by fitting the holders with electric connections, which will give warning when they still have a certain amount of gas to discharge. To prevent too great trust being put on these electric connections, it is also proposed to fit tell-tales to show when connections are made, and to rule it a misdemeanour for the attendant to allow the holders down so far as to make possible these connections and consequent warnings.

The house which contains the machinery measures 39 feet by 35½ feet by 35 feet high inside, and has windows on the four sides—twelve in all—each 9 ft. 9 in. by 3 ft. 2 in. The house is thus very well and evenly lit, as should be all houses containing machinery. The upper parts of the windows are filled in with obscured coloured glass, to hide the interior overhead girders from outside view.

Immediately after the main leaves the exhauster-house, it has to cross a three-lined railway. The only bridge over this is already crowded with mains; and the hanging of a new main outside the parapet was not feasible. It was therefore resolved to carry the main over the railway by a new route; and a pipe-bridge was designed and erected. (See fig. 4, on p. 112.) A tunnel was first thought of; but anticipated difficulties with water and foundation caused the ultimate adoption of the overhead system. The connections to and from the bridge are 30-inch, as is also the steel overhead main between the cast-iron columns of the bridge itself. The columns are built up of square box-castings with internal flanges; the bottom castings having broad bracketed external flanges to connect with the foundations. The take-off mains on each side are placed so that they enter adjacent ground with a proper cover over them; the columns themselves being carried down farther than those to allow their bottom parts to be used as syphons. The head of each column supports one end of a steel box-girder, and has also a cast-iron expansion joint bolted to it. The 30-inch connecting steel main itself runs between these joints, and is supported by the box-girder. As this girder simply rests upon columns, and is not bolted to them, and as the overhead steel main is not bolted to anything, but is simply inserted into the stuffing-boxes of the expansion joints, it is clear that considerable expansion or contraction can take place without the columns becoming unduly strained. In the same way,

the position of the two columns, through vibration or subsidence, can alter very considerably without causing serious damage to the structure and probable interruption in the flow of gas. There

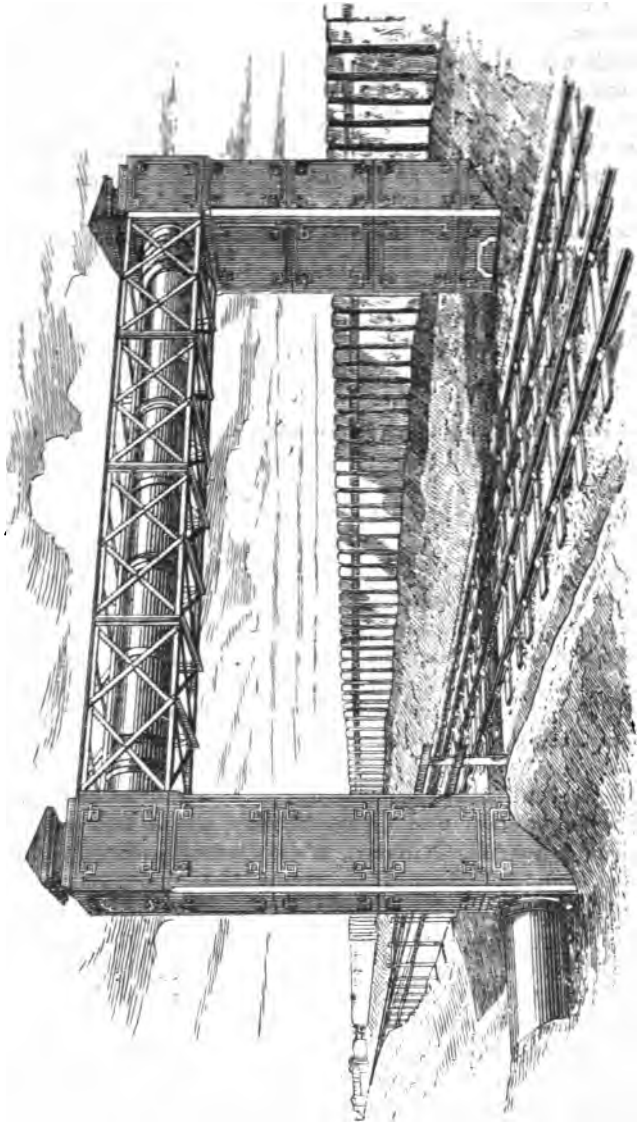


FIG. 4.—VIEW OF PIPE-BRIDGE OVER RAILWAY.

is 35½ feet clear breadth between the columns, and 16 feet clear headroom between the rails and the lowest part of the girder.

The main then runs for about 1210 yards through ordinary streets, and at present stops in the south roadway approach to the Redheugh Bridge across the Tyne. A new bridge of different design is at present being substituted for the existing one. This latter, as a portion of its structure, contains gas-mains, one of which has carried in the past, and is still carrying, the gas supply from the Gateshead works to the North of Tyne district. The new bridge is to carry the necessary low-pressure main for this purpose, as well as the high-pressure main now described.

To prevent any undue interference with the gas supply, a clause is inserted in the Redheugh Bridge Bill (1896) ensuring that during all the operations connected with the removal of the old bridge and the erection of the new one on the same site, the gas supply over the river shall not be interrupted for more than three days of 24 hours each, with a clear interval of at least three weeks between every such day; and that clear notice of two weeks must be served in writing by the Bridge Company stating the day on which, and the hour at which, the Company require the gas to be shut off. These conditions obviously increase the difficulties of the Engineers of the Bridge Company (Messrs. Sandeman and Moncrieff, MM.Inst.C.E., of Newcastle); but their arrangements and designs are such as to fully and skilfully meet the intricacies of the case.

The old bridge consists of two main lattice girders, supported by two approach buttresses and three river piers. The upper members of the girders are formed of 27-inch diameter riveted steel tubes, which are the only mains available for passing gas through. Unfortunately, the constant experience has been that the gas passes through in more ways than one; and from the extent of the vibration, due to traffic and storms, this could not be permanently remedied. The new bridge, when it is finished, will consist of a series of pairs of strong rigid girders running between the same number of supports; the river piers being entirely reconstructed with deeper and more substantial foundations. The gas-mains will be simply carried on projecting ends of cross girders, and will be made of 12-feet lengths of 27-inch diameter welded steel tubes, with solid flanged ends. Four cast-iron expansion joints will be inserted in suitable positions on each length of main.

After leaving the bridge, the high-pressure main runs through streets for some 780 yards, to the new governor-house. This, a building 54 feet by 39 feet by 28½ feet high inside, has a sunk

concrete floor on which are arranged distributing-box, valves, governor foundations, syphons, and mains.

There are three inlet supply-mains to the distributing-box—two, each 27 inches diameter, from the Gateshead works (one of which can also supply from the new works); and one, 30 inches in diameter, from the Newcastle works. The distributing-box is 5 feet by 5 feet cross section, and 54 feet long inside, with a depression at one end to form a syphon-box. It is built up of cast-iron plates 1 inch thick, and weighs 37 tons. Baffle-plates are placed in the box opposite the inlets, to prevent a rush of gas across to the outlets to the governors. There are eight governors (12-inch to 24-inch), and each is provided with a bye-pass.

On account of the rapidly rising street level outside, the outlet-mains from the house had to be at varying levels; and this is arranged for by running the outlets from the governors across the floor of the house to special syphons, the outlets from which are made at various levels to suit the street levels. From the end of the box a special main, 18 inches in diameter, is taken for part of the gas supply to Messrs. Armstrong, Whitworth, and Co., Limited. This firm, who are exceptionally large consumers, get part of their supply at from 4 to 6 inches pressure, to suit their special requirements. All flanges on connections in the house are bracketed and faced, and have bored holes, with turned and faced bolts and nuts. The working floor of the house is carried upon a series of steel beams and tees, and is constructed of steel buckled plates, cement, and ornamental tiles. It is placed at such a height as gives 6¾ feet headroom to the lower chamber.

The ventilation of the lower chamber is arranged for in the following way: The outside face of one wall of the house is kept 12 inches clear of the gable of the adjacent property. From the bottom of the open air-space thus provided, six 9-inch by 4½-inch inlet ventilator-pipes are run through the wall to the lower chamber; and upon the opposite side of the house six similar 9-inch by 4½-inch outlet-pipes are inserted, which run up the centre of the walls and find vent some 20 feet higher than the inlets on the opposite side. This difference in height suffices to induce a draught across the chamber. The method was adopted in preference to having any ventilator openings next to the street, at or near the ground level; and to still further prevent risk from explosion, the cross walls of the house are carried across the ends of the before-mentioned 12-inch space to isolate it from the streets. The interior ends of the ventilator-pipes are also provided with special hoods, to prevent burning soot, &c.,

entering from neighbouring chimneys. It is further proposed to carry a high-pressure air-pipe from the Newcastle works to the lower chamber, for use in blowing air when required. All these are precautionary measures only, as gas has been in the house for six months now, and no trace of escape can be detected.

On the upper floor of the house are placed a series of manholes and lids for access to the lower floor. These are also fitted above mandoors in the distributing-box. The valve standards for the delivery mains are in line near the large doorway; and further over on the floor come lines of valve standards for the inlets to the governors, the governors themselves, and valve standards for the outlets from the governors and for bye-passes. All the valve standards have indicators, to show clearly the position of the valves to which they are attached. A cabinet containing pressure-registers occupies the centre of the floor; and to each side of this is placed a powerful gas-stove. On the opposite wall from the large doorway is placed a cabinet containing pressure-gauges. In one corner an ornamental wood partition, 11 feet high, divides off the attendants' retiring room; while a similar partition in the adjacent corner forms a vestibule round the door, and also shelters the press for stores.

In the governor-house proper, and on the side of this vestibule partition, is fixed an arrangement of syphon-pumps. There are ten places to be occasionally pumped, though little water will be made. Instead of having either removable pumps or stand pumps, a special design was got out by which one fixed pump can do all the work of the place; while a second pump can be brought into use if required. The two pumps are attached to a polished mahogany board, and are about 6 feet apart. The two suctions are connected together, as are the deliveries. Cocks are placed near each pump on both pipes. From each syphon a pipe is connected on to the main suction-pipe, between pump-cocks; and each of the pipes is provided with a substantial and carefully-fitted cock near this connection. By opening the proper inlet and outlet pump-cocks, either pump can be used and worked on to whatever syphon-pipe has its cock open. The water is pumped into a 3-inch main, and run down to the Newcastle works. An observation chamber is provided on the delivery-pipe from the pumps, by which the attendant can see when gas is being drawn instead of water. The installation is finished complete (unless pump-handles) in burnished brass and copper. The governor-house and contained apparatus can be bye-passed, and gas passed directly, in case of emergency, from the works supply mains to the distributing mains.

The 30-inch connecting main, 320 yards long, from the Newcastle works to the governor-house, calls for no special comment. The 24-inch connecting main, 7160 yards long, from the new works to the governor-house, is not completed; but the first 4200 yards is now in operation, and is temporarily supplying a district that will ultimately be served from the new works.

To illustrate the difficulties met with when laying large mains in streets, a short description may be interesting of the track taken by a part of this main. Imagine a small hill-ridge with a valley on each side, the whole covered with streets and buildings. Along the top of this ridge runs an old street full of sewers and large pipes. Another street from the centre of the town approaches this hill-ridge at right angles, crosses the street on top, and, not quite opposite, but nearly so, continues in two streets across the opposite valley. One of these streets falls with the natural level of the hill-slope, and joins the street in the valley running parallel to the street on the ridge. The other, the main road, running from the ridge across the valley on a series of arches, crosses the valley road, and has a connection with it by a series of steps. The 24-inch connecting main coming up from the centre of the town had to be carried across the ridge road at a depth of 10 feet, to clear sewers, &c.; and as the arched road opposite had no cover for such a large pipe, and as it was not possible to hang the pipe anywhere on the sides, the main had to be taken down the road into the valley and carried up below steps into the main road beyond the arches. Nor was this all, for the local Water Company also required a large main carried under the same steps at the same time; and very careful work was necessary, and a large amount of concrete was used, to ensure safety to the gas-pipe, and to avoid unnecessary damage to Corporation property.

Nearer the new works, the Ouseburn Valley had to be crossed. What is known as the New Glasshouse Bridge carries the road across this; but, as usual in most bridges, no cover could be got in the roadway for a 24-inch pipe. Various proposals were made —to divert the main down side streets, and carry a small special bridge at a low level over the stream; to take the main by the same route, but tunnel below the stream; to hang the main on the side of the bridge; to carry it alongside on piers; to run it through brickwork below the springing of the arches; to remove a parapet, and put a hollow iron one on, through which gas could be passed, and so forth. Permission was ultimately obtained for us to remove an existing 8-inch gas-pipe from the footpath into the carriage-way of the existing bridge, and to alter the

position of a 9-inch drain—thus leaving a considerable breadth free below the footpath on one side. A special steel main was then constructed, nearly rectangular in shape, 40½ inches broad, one side 19½ inches high, the other 18 inches outside measurements. The main is built in 12 feet lengths of ⅜-inch steel; the ends being made of internal 2¾ inch by 2¾ inch by § inch forged angle frames riveted to the sides, and then faced. Manholes and doors are fitted near each end of each piece, so that the internal jointing bolts can be manipulated. When clear of the bridge masonry, special steel dropping end-pieces complete the special pipe. The end-pieces are carried down sufficiently to form syphons; the ordinary 24-inch cast mains taking off into the roadway at the proper depth some distance above the syphon bottoms. The special main is laid with one side about 2 inches clear of the parapet, on a prepared surface of tar and breeze spread on masonry. A brick wall is run along about 2 inches clear of the other side; and in these 2-inch spaces at each side of the main the tar and breeze are also run solid. This is also spread on top. Yorkshire landings are run in one piece from parapet to kerb, to form the pavement; their own weight and the weight of the traffic being taken by the stringing course of the bridge and by the brick wall. The special main is provided with a 10-inch bye-pass and necessary valves. The 10-inch main and also the 8-inch main removed out of the footpath are placed in the roadway; the want of proper cover being made up by casing both pipes in a block of concrete running the entire length of the bridge.*

Discussion.

The PRESIDENT said he was sure that the best way they could reward Mr. Gibb for his very able paper, and also for the preparation of the marvellous diagrams which they saw upon the wall, would be to give the paper a most full discussion; and he thought he was safe in saying Mr. Gibb would not be averse to any criticism.

Mr. A. C. HOVEY (Tynemouth) said he could readily imagine Mr. Gibb's very mingled feelings—perhaps he might call them depression and determination—when he first of all began the

* Mr. Gibb's paper was illustrated by a series of fourteen diagrams, most admirably finished in point of proportion and detail. The draughtsmanship was of such a high order that the Editor of the *Journal of Gas Lighting*, in a note at the end of the paper, expressed his pleasure in acknowledging their merit. He gave the acknowledgment all the more readily on being informed by Mr. Gibb that some of the most highly finished of the series were the work of a second year's apprentice, only seventeen years of age.

formidable work he had described. The laying of mains he considered to be more or less a thankless task; the work was so covered up that outsiders had very little idea of the difficulties which gas managers had to contend with in going along the track, and which had been so well described to them by Mr. Gibb. It was not everyone who had the opportunity of making such a nice arrrangement as they saw in the governor-house illustrated. It would long stand as a monument to the ability of Mr. Gibb in accomplishing the work. He considered there was no work so important as the laying of mains, because when they were once covered up it was a difficult and costly task to remedy any workmanship which might not have been creditably executed. With reference to the steel main across the railway bridge, he would like to ask Mr. Gibb how the main was tested during the progress of the work. He could readily see that any leakage after it was done could be tested by an arrangement for shutting off the valves which were upon each end; but if leakage were discovered, it would be a difficult matter to remedy it. Shortly after he was appointed assistant at the Tynemouth Gas-Works, Mr. Hardie recommended his Directors to replace a then existing main from North Shields to Cullercoats, a distance of over two miles. This was necessitated by the great pressure required in forcing the gas to the outlying districts which they supplied. The difficulties to be contended with were somewhat similar to those which Mr. Gibb encountered, though Mr. Gibb's were on a much larger scale—more especially in connection with the bridge. They also had a bridge; but fortunately they were able to get across it by means of brackets on the side of the structure. Mr. Gibb did not give them any particulars regarding the time taken in getting through some of the difficult portions of his work. This might be very useful to them in estimating the period required to carry out such operations. Also, if it would not be asking him too much, he might give them the cost per yard of laying such large mains. It was a very difficult matter to estimate the outlay on such work, on starting it; and they all liked to be as near the estimate as possible on the completion of a contract. In their work at Tynemouth, they had to go underneath a sewer, at a depth of about 14 feet, and to rise on the other side; and they had quicksands to go through. In the roadway, too, where the road had been relaid over and over again, till there was three times the thickness of macadam on the road, they met such things as not only upset one item but upset all their calculations when they came to lay the results before a head official. He should like to thank Mr. Gibb for his paper,

which had been most pleasant and instructive to him; being on a subject in which he had some special interest.

Mr. E. H. MILLARD (Durham) said it required a considerable amount of nerve to even try to grasp the whole of the details so admirably set forth in the beautiful diagrams; but he had been trying his best to see whether he could not find some point on which he really might criticize the paper—an odd point or two on which he might think that he could have done better. It was a large matter to tackle upon a cursory view. He must say he was surprised that, in the arrangement of the governor-house, Mr. Gibb had not thought it worth while to put in an automatic safety bye-pass governor. They all knew how liable a man was to make a mistake. Suppose the man were—as had been done repeatedly—to close one valve before opening the other, all the beautiful arrangement, so far as he could understand it, or as referred to in the paper, would be thrown idle. He thought that if a bye-pass governor had been included, in which the valve would open on the pressure falling, the supply would be kept up, and that it would also obviate any fear of drawing in one of the gasholder crowns. He remembered reading, not long ago, of a south country watering-place being thrown into darkness, simply through the gasholder outlet having been stopped with naphthalene, and a man who had commenced to pump having pumped till no water came, and then, thinking it was all clear, turning it on to the town, when he had been pumping air. The result was that the town was thrown into darkness. A governor of the description he had indicated would have obviated this. As to expansion joints, he must say that, so far as his experience of stuffing loose expansion joints went, unless they were very rigidly looked after, they were of very little use indeed. They practically formed a solid pipe in a very short time, unless the stopping or caulking were repeatedly renewed, which was not usually done. He had occasion recently to take out some expansion joints, which, he was certain, had never moved from a few weeks after they had been put in—possibly on account of the stuffing not having been renewed. He thought these were the only points upon which he could attempt to discuss Mr. Gibb's paper. They must all realize the endless pains and worry Mr. Gibb must have undergone in the course of laying those 5 or 6 miles of large mains. It was difficult enough with 12-inch, but when they came to 24-inch and 30-inch pipes, they found they took some handling.

Mr. T. BOWER (West Hartlepool) said it was extremely difficult to discuss a paper such as Mr. Gibb had put before them,

inasmuch as it fell to the lot of very few men to have to design, or to be connected with, new works of such magnitude. Hence any criticism which could be offered on a paper of this character would be only upon such small points as might arise upon the methods or arrangements of the plant. The Association would be greatly indebted to Mr. Gibb for the very able manner in which he had put before them the particulars of what he might most describe as a unique system of coupling up the distribution of gas. If Mr. Gibb had taken a comparative amount of trouble with all the works he had in hand for the Newcastle Gas Company, he was quite sure that the Directors of the Company would feel that in Mr. Gibb they had an official they might very well be proud of. He thought everyone who had any knowledge of the labour that was necessary in the preparation of drawings, would realize the amount of thought, care, and attention, as well as hard work, which had been bestowed upon what they saw before them; and, should it be for no other reason than this, the Association must be very greatly indebted to Mr. Gibb. As he said before, it was exceedingly difficult to raise a discussion on any of the points in the paper. Mr. Gibb mentioned, what they must all of them experience, that in laying mains in busy streets it was very difficult to get over the many objectionable matters that had to be encountered. He was then engaged in laying a new main of 30 to 24 inches diameter, tapering down to 21 and 18 inches; and they had found great difficulties in the work. It had often occurred to him whether some system could not be adopted, or mutual arrangement come to between the various authorities who had power to break up the streets, whereby a certain portion of the roadway would be allocated to the authority for sewers, another portion to the gas company, a further portion to the water company, and so on, to all the other authorities who had the necessary power to break up the streets. He knew how difficult this would be to accomplish; but if anything tending in this direction could be attained to, it would be a very great boon to those engaged in the laying down of distributing plant for gas and water works. Mr. Gibb spoke of the pumping of the gas. As he was contemplating some extensions in this direction, he would like to ask him what was his experience in regard to the loss of illuminating power in the process. They had authorities who said the loss of illuminating power was very great; and they had others who contended that it was very small. If, therefore, Mr. Gibb could give them his experience in this direction, it would assist him personally, and he had no doubt many others. Then there was another matter

mentioned by Mr. Gibb, upon which he would like (for his information particularly) to give a word of caution. This was with regard to the proposal which he made to have electric connections for his various gasholders and governor appliances. For the last eight or nine years, he had been working the water-levels in the towers connected with the water supply of West Hartlepool by similar means. When the apparatus was working satisfactorily, it was a great boon to them; but when it was not in this condition, it was far worse than having no apparatus at all. If any of them, as gas managers, on any particular Saturday night, when they were looking for, and almost counting, the last rivets, expecting that they had an abundant quantity of gas in the holders, should find it to be otherwise, owing to the electric apparatus having gone wrong, serious consequences might ensue. He had not had all the help that he expected from his own electrical connections. Mr. Gibb did not tell them the class of governor he took; but he had no doubt he had some contrivance, or some governor, which would to an extent answer the purpose which Mr. Millard had mentioned. In the case of any of the governors going wrong, he seemed to have a most perfect bye-pass arrangement during the time of any inconvenience. But, as Mr. Millard remarked, if it should be through the wrong opening or closing of a valve, this bye-pass arrangement would not apply. As to the using of a public highway by them for other than gas distribution purposes, this might lead to serious consequences. The use of the public highway for the conveyance of liquor and the like he thought was not contemplated in the General Acts; and it might lead to serious trouble if it were attempted. He believed that trouble had arisen through their design to lay down a main in the public highway to carry gas liquor.

Mr. W. J. WARNER (South Shields) said that main-laying was such a common subject that there was scarcely any scope for remarks upon it. He would rather, therefore, not refer to what Mr. Bower had said. He thought they had powers, in the Gas-Works Clauses Act, for using pipes for the purposes mentioned by Mr. Bower, if necessary, or if it were considered to be an essential part of the distributing plant. On another subject referred to by Mr. Bower, the question he asked could, perhaps, better be replied to by the author of the paper; but he might also give them his own experience. The South Shields Gas Company had two works—one at Shields, the other at Jarrow. They were four or five miles apart; and for years they had worked from one station to the other. By means of the main

from Shields, they used to draw gas into the holder at Jarrow. They were now working the other way; and the question of illuminating power having been raised by their own people, it was very closely and very carefully looked into. They could not detect any deterioration of the lighting power of the gas due to transmission from one station to the other. With reference to what he might call the districting of the roads—the setting apart of a portion of each street for the operations of the different authorities who had powers to break up the roads—he thought this would be somewhat difficult to accomplish. There were all sorts of difficulties—theoretical and practical—in the laying down of a long line of main; but, in his opinion, they could only be dealt with at the time of carrying out the work. He had occasion last winter to lay large street mains and connections; and at one place, after they had opened the ground, everything appeared to be clear. There were the ordinary sanitary arrangements, disused sewers, drain-pipes, electric wires, the water company's mains and valves, and their own connections. When they got farther down, they found an old sewer. They were obliged to tunnel under the road, and to divert the sewer and drains, before they could complete their work. Such things, he thought, it was not possible to anticipate; they must do their work according to the exigencies of the work itself. The governor-room that was shown on the diagram looked to be very simple; what complications there might seem to be in it were more apparent than real. He believed, himself, not only in having bye-passes to each governor, but in having bye-passes from one main to another, so that he could cut off one district and turn on the apparatus pertaining to another district. He might say that he thought distributory arrangements would become more complex as time went on. He expected they would require to duplicate parts of this plant, so that the pressures might be more even over the district.

The PRESIDENT closed the discussion by joining in the thanks expressed to Mr. Gibb for his most able paper. He thought he had shown some very ingenious arrangements. The automatic cut-off valve seemed to be a most useful appliance for its purpose; and, judging by its appearance, he thought it was very unlikely to fail. He must also congratulate Mr. Gibb upon his having introduced such a large installation of gas-engines for driving his exhausters. He should think it was one of the largest in the country for the purpose; and he trusted it would be highly successful. Looking at the drawings, he must say he rather thought that the distributing-box had the appearance of

putting all their eggs into one basket. It might not go wrong; but if it did, there seemed to be no provision to get past it. In his opinion, it would be better to have bye-passes on one or two of the mains, to get past the distributing-box. He should like to ask how the governor-house was lighted—whether any precautions were taken against explosion by escaping gas. In a great many governor-houses, the use of naked lights was expressly forbidden. In conclusion, he should only say that Mr. Gibb had had a grand opportunity, and had availed himself fully of it. He was sure his reputation would he enhanced thereby.

Mr. GIBB, replying to the discussion, said he felt very much gratified with the kind way in which they had received his paper. It was always pleasant to know that one's efforts were appreciated by others. Mr. Hovey asked about the testing of the steel main across the railway bridge. It was specified, and was tested in the contractors' works to a pressure of 5 lbs. per square inch. It was obvious, from the shape of the main, that it would not be advisable to test it to any further pressure. They, however, insured it against leakage by specifying that the ends of each piece should be riveted in position; and that then the ends should be faced, in order that they should have the main, which was of some considerable length, running true, without, as was sometimes done, "springing the joints" in getting it into line. Mr. Hovey also asked the cost per yard of laying large mains. He was almost afraid to mention it, because Newcastle workmen had such large pay, and did so little for it. But he found that in outlying districts, where there were not many difficulties to be met with, and where the work was simply digging the trench, laying the main, filling up, and reinstating the surface of the road, with mains of from 10 to 12 inches and upwards, it was a very good rule to count the total cost per yard as, in shillings, equal to the inches in a diameter and half of the main. Thus, with an 18-inch pipe, the total cost would be 27s. per yard; and with a 20-inch pipe, the total cost would be 30s. per yard. In a town, where matters were more expensive, the cost was double the diameter in shillings per yard. His last year's working bore out this statement very accurately. As to the length of time required for such work, he was really not in a position to say exactly what it would be. He only knew that the report of which these works were the outcome, was dated about two years back; and that the works had practically been done within that time. Mr. Hovey referred to a difficulty with which Mr. Hardie and himself had been met. They had been kind enough to bring up a drawing of this part of their

work. It was most interesting, and probably showed a greater difficulty than any that he had ever met with in Newcastle. Mr. Millard said he was surprised that there was no automatic bye-pass valve in the governor-house. As a matter of fact, they had eight districts; but not one of the districts was entirely separated from the other. They were all connected by subsidiary mains; and he calculated that if one governor broke down, the area it served would be supplied from surrounding districts—at, it was true, a pressure reduced by about 3-10ths—until the damage was repaired. But he did not think there was much danger of anything of the kind happening, because, in a governor-house of that size it was absolutely necessary to have an attendant present both night and day. It was not a case of having an isolated governor, and a man locking up the house at night and leaving it without attendance. But even in the event of the man not being there, any district would be served from the surrounding districts, through cross-connections which were never shut, which would not keep up a full pressure, certainly, but which would still prevent the district being entirely cut off. He did not know where Mr. Millard would put the valve to prevent damage to the crown of the holder. Would it be between the holder and the exhausters?

Mr. MILLARD: Yes.

Mr. GIBB: I anticipate that that would allow the exhausters to draw air.

Mr. MILLARD: No; to draw gas from another holder.

Mr. GIBB said that in that case it would not be necessary to have an automatic valve, because they never drew gas from more than one holder at a time, and it would therefore only be in the event of the last holder grounding that any damage could be caused. They had five holders, all of which would require to be connected with the valve. He felt disposed to modify Mr. Millard's statement regarding stuffing-boxes, and to say that these boxes only became stopped when they were put into places where they were not required. If they were located where they were needed, then night and day, summer and winter, there was such a movement as prevented solidification. He was exceedingly gratified to get such a friendly criticism from a Gas Engineer of the experience of Mr. Warner. He might explain, as it was, perhaps, not altogether apparent from his paper, the reason why the box-girder was introduced to support the pipe and the stuffing-boxes were placed at each end. The lines of railway were not passenger but colliery lines, and just beyond the bridge there was a very steep incline. He anticipated that

there would be, and there certainly would be, engines standing below the bridge getting up steam to take them up the incline; and in this case there would be cinders, or at least very hot vapours, playing against the bridge. So it was necessary to take elaborate precautions against explosion in the event of gas escaping. Mr. Bower had asked about the loss of illuminating power in gas transmitted long distances. Well, unfortunately, any knowledge he had on the subject was only theoretical. He had written to various people on the subject, and he thought the replies he received all went to show that in using small pipes, on account of surface friction, there was loss of illuminating power; but the experience was that, in employing large pipes, it was very difficult to detect any depreciation. He was grateful to Mr. Bower for his warning as to electrical connections; but a perusal of his paper would show that he did not place any great reliance upon them. In the first place, a man was there to look after them; but, in the event of his dozing or going to sleep, the ringing would warn him. So he really kept up these things as a second string. Mr. Bower raised the very important question as to whether gas companies had power to lay pipes other than gas-pipes in the streets. It had been suggested to him that the best way to solve the problem would be to lay them first and then to argue the point. No such powers were given in the Newcastle Acts, and he very much questioned whether the General Gas Acts gave the power; but the City Engineer had granted him the permission he had asked for. As to the bye-passing of the distributing-box, he could do that, in the event of the box being blown up, because he had provided against it by connecting the mains from the works to the mains in the streets. He had also tried to prevent the necessity for bye-passing by putting in a very strong box. It lay upon a heavy foundation; and he did not think that, in his time at all events, the box would break down—at least he sincerely hoped it would not. He begged to thank the members for their kind remarks.

Mr. ERNEST F. HOOPER (Sunderland), an associate member, then read the following paper:—

COAL TAR AND THE PREPARATION OF ITS PRODUCTS.

The notes which I have the honour to bring before you to-day, with your permission, I will divide into three sections—firstly, a brief historical summary of coal tar; secondly, coal tar and its constituents; and, thirdly, how its products are prepared.

The history of the manufacture of coal-tar products is contemporaneous, as a whole, with its sister craft the gas lighting

industry. It would appear, however, according to Dr. K. Lunge, of the Zurich Polytechnicum, in his monumental work on tar distillation, that the heavy tarry bodies produced on heating coal with a limited supply of air, were noticed and brought into use long before the pioneer of coal gas—William Murdoch—devised means for using the gas as an illuminant.

The coal tar obtained in the manufacture of coke similar in character to that produced in a gas-retort, was investigated in the latter part of the seventeenth century by J. J. Becher, who recommended its use for preserving wood or ropes. Clayton, in 1738, dealt with coal by destructive distillation, and gave notes as to the production of inflammable gases, coke, and tarry bodies. Both men were undoubtedly leading up to the now historical work of the gas pioneers who first put the manufacture of coal gas as an illuminant on a practical basis.

In the earlier stages of our allied industries, two facts stood out at once requiring immediate attention—firstly, that the coal gas must be purified from tarry bodies very considerably before use as an ordinary illuminant; and, secondly, that coal tar thus obtained must in some way be manipulated or altered before its qualities as a paint or preservative could be widely used (coal tar being at this time of no commercial value whatever). Hence at the end of the eighteenth century, and synchronically with the first public use of coal gas, steps were taken to boil the tar—firstly, in open vessels, and later on in closed boilers—to free it from its then unknown and undesirable acrid and spirituous constituents, which rendered it difficult to use and ill-adapted as a varnish or paint.

Between 1768 and 1838, it became apparent to engineers who were using large quantities of timber for constructive purposes, and in the later years when sleepers for the railroad permanent ways were required, that some measure must be adopted to protect the timber from atmospheric change, the ravages of insects, and general deterioration. With this object in view, numbers of patents were taken out to attain the result; among the most important being the following: Kyan, who early in the eighteenth century introduced the injection of mercuric chloride (corrosive sublimate). Boucherie, in 1767, patented injection of copper sulphate. Sir William Burnett, in 1815, patented injection of chloride of zinc. Paine later on used an injection of ferrous sulphate and sulphate of barium. Bethell, in 1838, introduced the injection of heavy tar oils. The latter system is practically the sole survivor of the various processes devised, and one in very extensive use at the present time.

A monograph of great interest has been written on the subject of "Creosoting: Its History and Application," by my late chief, Mr. S. B. Boulton, of the firm of Messrs. Burt, Boulton, and Haywood. The paper was read before the Institution of Civil Engineers, and appears in Vol. 78 (1883-4) of the "Proceedings" of that Society.

The whole question of timber preservation by coal-tar oils is one of great importance to engineers; and of the practical value of this process there cannot be two opinions. But, strangely enough, the theoretical views relative to the usefulness of the constituent bodies are exceedingly divergent; and tar distillers nowadays have to be prepared to fulfil a great variety of specifications.

During the earlier years of this century, many eminent chemists made the study of coal tar and products a matter of special research. Benzene was first eliminated from tar in 1845, by A. von Hoffman. Charles Mansfield first prepared it in quantity in Hoffman's laboratory; this hydrocarbon having been prepared by Faraday in 1825, and Mitscherlich in 1833, from other sources. Toluene was first prepared from resin gas residues by Mitscherlich, in 1838, and proved to be a constituent of coal tar by Mansfield in 1848. Xylene was discovered by Cahours in wood naphtha, and eliminated from coal tar by Ritthausen and Church. Fittig, in 1869, proved that it consisted of certain isomeric bodies; and Jacobsen, in 1877, isolated the three xylenes. Naphthalene was first discovered by Garden, in 1820. Anthracene was discovered by Dumas and Laurent in 1832, and prepared by Fritsche from coal tar in 1857. Phenol (carbolic acid) was discovered in 1834 by Runge; and its preparation from coal tar engaged the attention of many eminent men of science about that time.

Aniline, the parent of the coal-tar dyes, was artificially prepared by Unverdorben in 1826, and discovered as a coal-tar constituent by Runge in 1834. The aniline, as such, in crude coal tar, however, was never found in sufficient quantities for commercial use. [In experiments I have recently had occasion to make, I have obtained, after repeated fractionations of heavy coal-tar bases, a complex body containing as much as 30 per cent. of pure aniline.] Runge first obtained brilliant colouring matters by the action of chloride of lime (calcium hypochlorite) on aniline; but it was left to the eminent chemist Dr. W. H. Perkin, who is happily still with us, to prepare in 1856 for the first time coal-tar colours of the aniline (mauveine) series on a large scale.

In 1859, Verquin prepared aniline red in quantity. Aniline black, Lightfoot discovered in 1863. Graebe and Liebermann synthesized alizarine from anthracene in 1868. Eosin dyes were prepared by Baeyer in 1874; and since then azo dyes, benzidene dyes, and diazo dyes have been produced. In 1880, Baeyer had so far advanced with his work on artificial indigo that the Badische Anilin und Soda Fabrik put on the market a product from which artificial indigo could be produced on the fibre.

From the year 1860 onwards, it may be considered that the manufacture of coal-tar products raised itself into a distinctly scientific industry; and at the present time we may claim that for itself and its dependent industries no form of applied engineering or chemical skill is too intricate or delicate to prepare and build up the thousand-and-one colours, drugs, perfumes, and other bodies of general usefulness, emanating from this almost supernatural bye-product.

Of late years, owing to the demand for particular types of bodies, tar distillers have had to devise methods and plant for preparing several bodies in a high state of purity; chief among these being benzene, toluene, the xylenes, phenol, cresol, pyridine, naphthalene, and anthracene—the latter being produced to contain a minimum of 30 per cent. pure anthracene.

Having dealt in brief with the general history of coal tar, we will turn our attention to the body itself. At the present time, the annual make of coal tar throughout Great Britain, from obtainable statistics, seems to point to a figure of between 800,000 and 900,000 tons; and from the value of products at the present time, we seem to have reached the point where the supply is in excess of the demand.

High heats are undoubtedly the order of the day. Consequently, the hydrocarbons of the methane (paraffin) series, of which methane (CH_4) is the simplest type, as far as my information goes, are practically unknown in ordinary coal tars; the high heats producing almost exclusively the hydrocarbon compounds rich in carbon—*i.e.*, the aromatic or benzene series. The molecular condensation as the temperature increases carrying with it the separation of hydrogen, higher bodies still of the naphthalene, phenanthrene, and anthracene types are produced; the oxygen assisting in the formation of the phenol (carbolic acid) series. A high or low ratio of heat in the retort consequently means a considerable difference in the actual analytical contents of the tar relative to its products; the tendency of late years being to produce a larger quantity of gas

and denser tars—the latter being almost at times comparable to pitch itself.

I have endeavoured to trace the specific gravity of tars in the earlier days, probably about the time of cast-iron retorts; but with little success. It seems, however, that with the use of the iron retorts about 6000 to 6500 cubic feet of gas would be produced from one ton of Newcastle gas coal. Mr. L. T. Wright some time since gave a series of figures showing that, on this basis, the specific gravity of the tar would be about 1068. Later on, with clay retorts and higher temperatures, the specific gravity of the tar rose to 1120-1150. I find also that the specific gravity of tars produced in 1882 averaged from 1175 to 1215; in 1888, the specific gravity rose to an average of 1205; and at the present time the average tar will vary from 1220-1240. These data point to the fact that more pitch and free carbon are included in the tar year by year, and less oil and lighter products.

An analysis of tars of different gravities may here prove interesting; and they are given in the following table. The first, second, and fourth analyses are taken from Mr. Lewis Thompson Wright's figures; the third is an average tar as at the present time.

Specific gravity.	1086.	1140.	1200–1230.	1206.
Crude naphtha.	9·17 per cent.	3·73 per cent.	1·5 per cent.	1·00 per cent.
Light oil . .	10·50 ,,	4·47 ,,	1·3 ,,	0·57 ,,
Creosote . .	26·45 ,,	27·29 ,,	14·5 ,,	19·44 ,,
Anthracene oil.	20·32 ,,	18·13 ,,	16·0 ,,	12·28 ,,
Pitch . . .	28·89 ,,	41·80 ,,	60·0 ,,	64·08 ,,
Cubic feet of coal gas per ton . .	6600	8900	10,000	11,700

From a communication made by Mr. Irwin to the Manchester Section of the Society of Chemical Industry, in February of this year, this assumption is confirmed; as he shows, firstly, that higher temperatures mean less benzene, phenol, and xylene, and more naphthalene and pitch—anthracene remaining fairly constant. He also emphasizes the high value of benzene as an enricher, though, as he points out, in the test as shown by the argand burner—now practically out of use by the public—the figures are less favourable to this enricher than with other burners. I believe it is generally assumed by gas engineers that benzol at or below 1s. per gallon is unequalled as an enricher, and solvent for naphthalene, by any other body. As it is considerably below this figure now, and likely for the future to remain so, owing to large production, this matter is worthy of close attention at the present time.

The whole question of the enrichment of coal gas for illuminating purposes, and dissolving naphthalene in the mains, has been ably dealt with by Dr. P. Eitner before the Mid-Rhenish Association of Gas and Water Engineers. An abstract of the paper appears in the *Journal of Gas Lighting* for Feb. 21, 1899, and is worthy of close perusal. He adduces proof that the benzene homologues stand at present far above other solvents in value ratio, and that the xylene bodies show the best results of this particular series.

Up to the present time, as far as I can ascertain, there are about 150 to 200 bodies of different identity actually present in coal tar. Still, undoubtedly many more are existent; but they have not yet been isolated in a state of sufficient chemical purity to warrant their inclusion in authoritative lists. Many are gaseous, more are liquid, and a large number are solids at ordinary temperatures. The majority, when chemically pure, are white; the oils, water white; and the solids, crystalline bodies. I have the pleasure of showing you some of the better known bodies prepared in a high degree of purity. Some of the more important are given in the following table:—

Name.	Type.	Boiling-Point. °C.	Specific Gravity at 0°.	Formula.
Benzene . . .	Liquid	80·50	·899	C_6H_6
Toluene . . .	,,	111·00	·882	C_7H_8
Xylene ortho . .	,,	142·50	·756 at 14°C.	C_8H_{10}
,, meta . .	,,	139·80	·878	,,
,, para . .	Solid	138·00	·862 at 19·5°C.	,,
Naphthalene . .	,,	218·20	1·145 at 4°C.	$C_{10}H_8$
Acenaphthene .	,,	265·75	1·03	$C_{10}H_{10}$
Anthracene . .	,,	360·00	1·38	$C_{14}H_{10}$
Phenanthrene .	,,	340·00		$C_{14}H_{10}$
Pyrene	,,	over 360·00		$C_{16}H_{10}$
Chrysene . . .	,,	436·00		$C_{18}H_{12}$
Phenol	,,	182·00	1089	C_6H_5OH
Cresol	Liquid	180-210		C_7H_8O
Benzoic acid . .	Solid	249·20	1·201 at 14° C.	$C_7H_6O_2$
Aniline . . .	Liquid	182·00	1026	C_6H_7N
Pyridine . . .	,,	116·70	·986	C_5H_5N

Professor Dewar, of the Royal Institution, informs me that he has succeeded in solidifying all the hydrocarbons of the benzene series that have come under his notice up to the present time; and it will be of great interest to learn their freezing-points.

The Preparation of Coal-Tar Products.

Having dealt briefly with the history, types, and constituents of the above, I will now explain the general method by which the crude tar is converted into the various products from which

subsidiary industries prepare their own specialities for trade purposes. In a large tar-works, the crude tar as it arrives, either by pipe, barge, railway-tank, or barrel, is emptied into a large reservoir constructed either of iron or cement. This induces a blending of the various grades of tar, making a fairly average product to pass into the stills. The larger this store-tank is the better, as it allows a greater quantity of supernatant ammoniacal liquor to settle on the surface, to be drawn off for use in the sulphate plant. The total ammoniacal liquor held by the tar in suspension, including the liquor from the stills and tar-heaters, amounts to about 5 per cent. of the tar with an average test of 4° to 5° Twaddel.

The crude tar to be dealt with day by day is then pumped into a smaller tank or boiler, heated internally by hot-air or steam pipes. The tar is raised to such a temperature that most of the remaining liquor will separate and rise to the surface by reason of its lighter specific gravity, but not to such a temperature that any of the lighter bodies will distil off or escape. From thence the hot tar is led into iron stills, each of which will generally contain 10 to 15 tons of tar, equivalent in measure to 2000 to 3000 gallons. The usual design of a still is an upright cylindrical iron or steel shell, built with a convex top and a concave bottom. A cast-iron still head-piece for collecting and condensing the distillate is fixed on the top, conducting the distillate to the worm. At the back is a run-off pipe for the pitch. Most stills are fitted with some method of internal agitation, and also steam-pipes with jets, to assist in driving over the heavier oils, and to prevent the pitch coking on the bottom plates; the agitation being continuous from the time the fires are lighted till the pitch has been run off into the coolers. The fires are lighted when the stills are full to the requisite level, and, of course, after steam has been blown through the still and worm to test that the pipes and connections are quite free and clear from obstructions. About an hour-and-a-half after the fires are lighted the contents of the still are raised to the point of ebullition, and the crude naphtha and ammoniacal liquor begin to distil over. At this stage, a large quantity of cold water must be passed through the condensers to cool the worm, and allow the light bodies to become condensed sufficiently at the receiving chambers to prevent loss by evaporation. A considerable quantity of gas is evolved from the tar at this period—no doubt owing to decomposition occurring.

The first fraction is usually termed 30 per cent. crude naphtha, and tests 30 per cent. by distillation at 120° C. This first fraction

will include the following bodies: Benzene, about 40 per cent., toluene, 12 per cent. and xylene, and in small proportions thiophene, pyridine bases, carbon-bi-sulphide and phenolic bodies. The specific gravity of this fraction will be about 900 to 920. About from three to four hours suffices to collect this distillate. The second fraction—No. 2 naphtha—is generally collected by measure, 100 to 120 gallons for a 3000-gallon still. This will contain small quantities of benzene, toluene, xylene, and their higher homologues, much naphthalene, and more phenolic bodies than the first running. It has specific gravity about 950 to 1000. This distillate will run for two to three hours. The naphtha will be redistilled in a naphtha still fitted with a small condensing tower, and the lighter distillate obtained run to the 30 per cent. crude naphtha; and the higher boiling point and remaining oils will be washed, to extract the phenolic and basic bodies.

Leaving the tar department the light crude naphtha fraction will be sent to the benzol-house, where these oils are washed—firstly with water, to free them from ammoniacal impurities; then with sulphuric acid to extract the basic bodies, as sulphates; and, lastly, with caustic lye or lime, to obtain the phenols, as sodium or calcium phenates. The basic and phenolic bodies are then dealt with in their respective departments. The naphtha is further treated with sulphuric acid, water, and soda lye, and then run to the benzol still—a wrought-iron or steel boiler, with a high condensing tower on the same fractionating principle, as the Savalle, Coupier, or Siemens columns, used for the fractionation of alcohol and such-like bodies. The distillate here will then yield 90 per cent. benzol—90 per cent. distilling at 100° C.—and besides this lower fractions (*i.e.*, toluol and solvent).

The next fraction collected is termed the carbolic oil run; the specific gravity reaching a little over 1000. It contains a small quantity of heavier naphtha, much naphthalene and other solid bodies, and about 5 per cent. of phenol crystallizing at 60° Fahr.; pure carbolic acid crystallizing at about 42° C., or 107° Fahr. This fraction of about 150 gallons will take about an hour to run from the tar-still. The carbolic oil is mixed with the heavier naphtha already mentioned from the No. 2 naphtha, and washed in the carbolic plant, with caustic lye, to collect the tar acids contained in the form of phenates. This body is then treated with sulphuric, hydrochloric, or carbonic acid—the latter as gas, the former as solutions—and decomposed into the sodium salts of the respective acids, and the bodies of which phenol is the most important. The remaining oil is then generally distilled by itself, and the lighter fractions retained for heavy naphtha;

the residue being run to creosote. These fractions, as well as the next in order, creosote, are always being altered slightly in treatment, according to the commercial value of the products contained therein.

The creosote fraction contains large quantities of naphthalene and the methyl-naphthalenes, and smaller quantities of the cresols and heavier basic bodies, mostly higher in the series than lutidine, which has a boiling point of 140° to 150° C. This portion of the distillate is allowed to cool in large open tanks. The liquid bodies are drained off, and employed for creosoting purposes, and also for use in "Wells" or "Lucigen" lamps. The naphthalene is then dug out in the form of a yellowish semi-crystalline mass, like raw sugar in appearance, which is then bagged, and pressed in hydraulic presses, or dried in a centrifugal machine. This semi-refined naphthalene is then put into a large lead-lined tank, melted, and agitated alternately with sulphuric acid and oxidizing agents—such as Weldon Mud or the bichromates—then with water, and lastly with a caustic lye. From thence it is charged into a naphthalene still, and the pure naphthalene distilled by fire into suitable receptacles. Further treatment for the preparation of nitro-naphthalene and naphthols—the former being largely employed in explosives of a smokeless character, and the latter used as the base of the naphthol colours—are carried out at some works. Crude naphthalene is also largely used by lamp-black manufacturers, for the production of carbon black for printing inks.

The running of this fraction takes about an hour; and when a sample on cooling sets to a buttery non-crystalline solid, distinct as from a crisp non-greasy body, the last fraction—anthracene oil—commences to run. At that point the fires are allowed to slacken, and steam at about 40 lbs. pressure is injected into the stills. The anthracene fraction takes some five hours to distil over. The distillate has a greenish colour, and a density of over 1050; and on cooling deposits an orange yellow crystalline mass of crude anthracene. This oily paste is passed through filter presses, and either bagged and pressed in hydraulic presses and ground, or dried by centrifugal means; and the dry crystals are then ready for export, providing they contain not less than 30 per cent. of pure anthracene by Meister, Lucius, and Brüning's test. Otherwise the poorer salts are washed with naphtha or creosote, to bring them up to the right standard of purity. The heavy oils are re-filtered, and are then ready for export for grease-making purposes. The anthracene is well known as the base from which artificial alizarine colours are all prepared.

The residue left in the still amounts to from 55 to 60 per cent. of the tar distilled, and is known as pitch. It is run off into air-tight coolers at the back of the still; this precaution being necessary owing to the fact that the pitch as run off from the still has such a high temperature that it would very probably ignite if brought at once into contact with the atmosphere. In these coolers, oil is added to make the pitch of the required consistency. From the pitch coolers, the pitch is run into large beds lined with cement, wood, or duff coal, on which each day's make is run, raising the bed from ¼ inch to 3 inches per diem. An alternate plan is to run the pitch into iron pans, from which each day the solid pitch is hacked out and stacked ready for use in various directions, as an agglomerant for patent fuel, for road grouting, the manufacture of black varnishes, asphalte, &c.

The notes which this paper contains, I should here mention, deal entirely with tar such as is produced from gas coal won in the North-Eastern district. The tar as obtained from Scotch, West Country, or Midland coal is altogether of a different character to that which I have described to-day; and I believe it would be of great interest to all of us if, on some occasion in the near future, a member of one of our Western Associations would favour our society with a brief *résumé* of results, methods, and statistics relative to the West Country or Midland tars.

Discussion.

The PRESIDENT said he was sure they were all extremely indebted to Mr. Hooper for his paper, which he had no doubt would form a classic they could dip into whenever they required to do so. The subject of tar distillation was very near to their particular work; and, in any case, they were supposed to know all about it. If at any time some of them should happen to have forgotten what they had once known upon the subject, they would be able to refresh their memories from the paper.

Mr. W. HARDIE, jun. (Tynemouth), said that he was sure they were all very much indebted to Mr. Hooper for coming before them with this valuable paper. It was not one which they would be able to criticize much; but it contained a great deal of matter of a sort which from time to time they wished to have, so as to be able to refer to it. It gave them much valuable information as to the progress which the coal-tar trade had made. Mr. Hooper dropped a remark about benzol; and he would like to state that for eighteen months or more this subject had somewhat interested him, because he had been using benzol, and nothing else, as an enricher. He quite agreed with Mr. Hooper

that, at present prices, nothing could compare with benzol for enrichment. Another point he would like to mention was that gas enriched with benzol told more favourably in a flat-flame burner than in an argand. This was much to the benefit of the consumer, because gas was invariably tested for illuminating requirements in an argand burner, and it was burned by the consumer in a flat-flame burner. The consumer therefore had the advantage of the difference. He wished to ask Mr. Hooper if he considered that a very small proportion of benzene vapour, when put into coal gas, was permanent—he meant, would it carry its enriching power right from the works to the consumer? He had this subject before him just now; and there certainly was no one better qualified than Mr. Hooper to give them the information.

Mr. HOOPER said he was pleased that his paper had not been quite so freely criticized as, perhaps, Mr. Gibb's; though the superiority of Mr. Gibb's paper was manifest. With reference to the question of benzol (benzol being, whether the gas were enriched or not, a very large constituent of coal gas) in the aiding of its illuminating power, there was no question that benzene was absorbed more readily by coal gas than probably any other enricher—and naturally so, because it was one of its own kind, one of its own kith and kin. If they took other types of oils —such as the paraffin—they would almost always find that the relationship led to association under every physical condition. Coal gas had been undoubtedly proved to absorb, and to hold, benzene very much more easily than any other body. Benzene, too, had, he believed, been entirely proved to be a far more permanent gas, in coal gas, than any other agent used as an enricher. It was somewhat difficult, perhaps, to speak of permanent gas, because practically every gas had now been liquefied or solidified. But they could induce coal gas to absorb an enormous quantity of benzene—far more than was necessary, in any way, for illuminating under ordinary conditions. But he believed he was right in saying that coal gas held benzene to a very large extent; and once having added benzene to coal gas, as an enricher, or as the solvent of naphthalene, they never got the whole percentage which had been added—should he say—let down in their mains in the form of a liquid. The benzene did not liquefy again in the mains; but he wanted them to know this fact, which he believed to be on all-fours with the fact that in the case of coal gas travelling long distances in small pipes, there was a diminution of lighting power, so there might be with benzene. He believed that this was due to the fact that

benzene was, like other illuminating bodies in the gas, precipitated in the form of, perhaps, fine vapour or dew, on the sides of the gas-mains. In this way it was undoubtedly a solvent of naphthalene; but at the same time gas enriched with benzene would hold benzene to any point, up to a certain percentage.

Vote of Thanks.

Mr. W. Ford (Stockton) asked the meeting to accord, in the most unanimous and cordial manner, their heartiest thanks to Mr. Gibb and Mr. Hooper for their valuable papers.

The motion was carried *nem. con.*; and Messrs. Gibb and Hooper each briefly acknowledged it.

Election of Office-Bearers, Etc.

The President reported that the ballot for the election of office-bearers had resulted as follows:—

President.—Mr. W. Doig Gibb, of Newcastle.
Vice-President.—Mr. E. H. Millard, of Durham.
Auditor.—Mr. Herbert Lees, of Hexham.
Hon. Secretary.—Mr. J. H. Penney, of South Shields.

For two vacancies on the Committee, Mr. Matt. Dunn, of Goole, was elected, and Messrs. W. Cowley and S. B. Walker, of Walker, tied.

The President gave his casting vote in favour of Mr. Walker, who, he said, was the more centrally situated.

On the motion of Mr. T. Bower, seconded by Mr. J. Whyte (Seaham Harbour), the President was thanked for his valuable services to the Association during his year of office.

The President briefly acknowledged the vote, and the proceedings closed.

The members and friends afterwards dined together in the County Hotel; the retiring President taking the chair.

SOUTHERN ASSOCIATION.

EXCURSION MEETING, MAY 18.

This Meeting was one of the pleasantest and most successful in the annals of the Association; the programme being an inviting one, and the weather favoured its realization. The proceedings began with a visit to the works of the Tottenham and Edmonton Gas Company; the numerous party being conducted over this very businesslike establishment by the President, Mr. E. A. Broadberry, who is associated in the management with his father, Mr. W. H. H. Broadberry. The Chairman of the Company, Mr. Corbet Woodall, and another Director, Mr. D. Ford Goddard, M.P., were present at this part of the function and at the lunch which followed, to do the honours of the district to the members of the Association, The compliment was highly appreciated; and the honourable member for Ipswich, as an old Gas Manager, seemed delighted to find himself once more in such congenial company. The undertaking of the Tottenham and Edmonton Gas Company is a very remarkable example of development, corresponding to the enormous growth of population in the district. The management are to be praised for the good order and neatness which have been preserved in the works under the trying conditions of something like a 20 per cent. annual increase. The large carburetted water-gas plant is one of the specialities of these works; and it is difficult to see how the requirements of the district could be met if any restriction were placed upon this manufacture.

After luncheon, which was provided by the hospitality of the Directors of the Gas Company, the party left in brakes for the Royal Small Arms Factory at Enfield, where the art and mystery of making those deadly weapons which have carried the British flag so far was duly admired. It was a most absorbing, but "headachy" place. From here the brakes conveyed the party through pleasant ways to the Royal Forest Hotel, Chingford, for tea. Subsequently a little formal business was transacted. It consisted of the election to membership of the

Association of Mr. J. H. Brown, of Ilford, and Mr. W. Wyver, of Whitstable. This being the first meeting of the Association after the lamented death of Mr. Frank Livesey (on May 3, 1899), whose interest in the organization was unfailing, a vote of condolence with the bereaved family was passed. The party then separated, mostly returning to London by an early train; and so concluded a well-filled and happy day.

The Secretary of the Tottenham and Edmonton Gas Company (Mr. James Randall) circulated among the members the following statement in regard to the prepayment system in vogue in their district:—

Average Cost of Fitting Up each House for the Supply of Gas by the Prepayment Meter System.

	£	s.	d.
1-inch wrought-iron service-pipe from main to meter laid by Company's own men, including ¾-inch brass main tap, cap, and lining and fixing inlet only of meter	0	18	0
Contract with gas-fitters for supplying ⅜-inch, ½-inch, and ¾-inch wrought-iron piping, and fixing same for five lights and boiling-burner	1	1	0
Fittings supplied by Company: Two brackets, 2-light pendant (brass), one iron do., and one boiling-burner, net cost	0	17	0
3-light automatic dry gas-meter, net cost	2	4	0
Total	£5	0	0

The expenditure to the 31st of December, 1898, for providing and fixing piping, gas-fittings, and boiling-rings, fitted in consumers' houses supplied by the automatic gas-meter system, including experimental free gas cooking-stoves (£76 3s. 8d.) was £12,327 10s. 11d. This amount has been transferred from capital (fixed plant account) to a separate account, and will be a charge, by instalments, against revenue as opportunity occurs. In addition to the amount charged for the ordinary repair of gas-meters, 5 per cent. is allowed for depreciation.

STATISTICS OF AUTOMATIC GAS-METERS FOR FIVE YEARS AND FOUR MONTHS.

Selling price of gas by ordinary meter, 3s. per 1000 cubic feet; do. by automatic meter, 3s. 8d. per 1000 cubic feet.

Years.	Part of 1893.	1894.	1895.	96.	1897.	1898.
Number of consumers	67	1,250	2,658	4,323	5,740	7,024
Total consumption . . . cub. ft.	238,100	8,372,000	26,282,200	43,129,900	64,323,600	85,880,400
Average consumption per consumer . . . . . „	3,554	6,698	9,888	9,977	11,206	12,226
Value of gas at 3s. per 1000 cubic feet	£41 3 6	£1,392 18 2	£4,328 13 5	£6,514 18 1	£9,729 3 4	£12,883 5 5
Apportioned for meter-rent	2 13 7	161 6 10	491 9 0	900 0 5	1,274 15 2	1,622 0 0
Apportioned for rent of fittings (balance)	Not allocated.	. .	. .	£567 14 4	£952 2 4	£1,525 3 4
Total amount taken from meters .	£43 17 1	£1,554 5 0	£4,820 2 5	£7,982 12 10	£11,956 0 10	£16,030 8 9
Rental of cooking-stoves.	0 1 8	7 5 11	18 2 3	76 7 7	129 19 6	182 8 10
Total—gas, meters, stoves, fittings. .	£43 18 9	£1,561 10 11	£4,838 4 8	£8,059 0 5	£12,086 0 4	£16,212 17 7
Average amount taken from meter per consumer.	£0 12 11	£1 4 10	£1 16 3	£1 16 11	£2 1 8	£2 5 7

MIDLAND ASSOCIATION.

EXCURSION MEETING, MAY 31.

The members of this Association visited their President (Mr. J. S. Reeves) at Bilston on the above-named day. Glorious summer weather and the long friendship which has existed between Mr. Reeves and many of the members were no doubt the two factors which had most influence in bringing together the fine muster which was to be seen in front of the High-Level Station at Wolverhampton just before noon. From thence, brakes conveyed, without delay, the party to the Bilston Gas-Works, where they received in the Board-room a cordial welcome at the hands of the President and three of his Directors—Mr. Harold Holcroft (son of the Chairman), Mr. J. W. Hall, and Alderman J. Annan, an old member of the Association, and former Engineer of the Wolverhampton Gas Company's works. Light refreshments, kindly provided by the President, were disposed of with just appreciation; and then the members prepared to inspect the works.

Before leaving, the President took the opportunity of making his visitors acquainted with some important work he had in progress, in order to bring his retort-house arrangements up to date, by reading the following account of it: The alterations and additions arranged for consist of the removal of the railway sidings from the inner to the outer sides of the coal-stores, the setting back of the columns supporting the roofs of the retort-house and coal-stores, and the erection of eight additional steel box-girders extending from the coal-store walls to the main girders of the roofs. Also the construction underground of engine-houses, the walls of which will be lined with white glazed bricks, the supply of two 10-horse power steam-engines, two coal-breakers, each fitted with two sets of steel claws, and two elevators, provided with Hunt's patent roller link chains and 12-inch buckets. There will also be a conveyor extending across the retort-stack, with gearing so arranged that the conveyor can be driven as desired from the head of either elevator. The present roof of the retort-house

not being sufficiently high to admit of elevators and conveyors, a portion of it will be cut away and a new roof erected in lieu of it. Two sets of West's manual charging-machines will be provided, with coal-hoppers carried by travelling trolleys. The power to raise and adjust these hoppers will be obtained by rope gearing from the heads of the coal-elevators. There will also be a fixed storage hopper on each side of the house, from which the travelling hoppers will be fed as they pass under. The charging and drawing machines will travel along rails in front of the retort-benches; but a slight curve in the rails will be necessary to meet the varying line of the retort-benches. The coke will be drawn from the retorts into waggons as at present, and be run underneath water-tanks, where it will be quenched. West's Gas Improvement Company have the contract for the alterations to the roofs and the supply of the machinery. The brickwork and alterations to the railway sidings are being carried out by the Gas Company, under the direction of their Manager.

After the reading of the foregoing, the members rambled through the works. They inspected the site of the additions so succinctly described; and saw something of what the President was able to accomplish with his Klönne furnaces, as modified by Mr. R. O. Paterson, of Cheltenham. It was also seen that Mr. Reeves is not a believer in hydraulic mains—his judgment in this matter being based on a six years' experience. These and other interesting features of the works were minutely investigated and ultimately praised. As to the nature of some of them, more may be learnt by a perusal of the address delivered by the President at the annual meeting in March (*ante*, p. 44).

Again mounting the conveyances, the members had a very agreeable drive, for the most part through beautifully green and well-wooded scenery to the Wombourn water-pumping station of the Bilston District Council; and a very interesting visit it proved to be. They were received there by the Engineer, Mr. C. L. N. Wilson, Assoc.M.Inst.C.E., who gave them most courteous attention. The station is very prettily situated, and consists of a noble castle-like, red (Ruabon) pressed-brick building, with Hollington stone dressing, window heads, &c. It is divided into area and pump room, engine-house, well-house, and a small fitting-shop, boiler-house, and coal-store. The stack, which is also of red Ruabon bricks, is 90 feet high. There are two engines of the vertical triple-expansion type, and surface condensing, with three force-pumps placed directly underneath the crank-shaft, and two well pumps driven from a pin

in a disc at the end of the crank-shaft, connected with a pitman of pitch pine to a pair of rocking bobs placed over the well; the pumps being about 140 feet from the surface of the well. The works were designed by Mr. Baldwin Latham, and were carried out with Mr. Wilson as Resident Engineer. The total amount spent on the undertaking by the end of the year 1898 was about £61,000; but of this £16,750 was paid to the Wolverhampton Corporation for their right of supply in Bilston and Coseley. The town was first supplied from the works on July 2, 1896; but they were not formally opened until twelve months later.

The return drive was a thoroughly enjoyable one; and it ended at the Victoria Hotel, Wolverhampton, where the Directors of the Bilston Gas Company entertained the members to luncheon. The Chairman of the Company (Mr. Thomas Holcroft, J.P.) presided; and he was supported on the left by the three co-Directors already named, and on the right by the President and the Honorary Secretary of the Association (Mr. C. Meiklejohn). There was a short toast-list, in the course of which the Chairman related a little anecdote of some historical interest to gas engineers. He said that, when Napoleon shut up the Russian ports, the difficulty cropped up as to how tar was to be obtained in this country. At that time a club existed known as the Lunar Club; consisting of James Watt, Boulton, Murdoch, Dr. Priestman, and others. The question of the supply of tar came before the members. Among them was John Wilkinson, and he was one of the cleverest of the lot, although he had not since come so prominently before the book world. It was he who developed the manufacture of iron in the district. The result of these men laying their heads together was that they (this was about 1806) came to the conclusion that they could get the tar they wanted from coal; and the place where they started to distil coal for the purpose was in Bilston. It was even now called the Tar Oven. They filled the ovens with coal; and in distilling it they necessarily produced gas, which they let out at the top of the ovens. When the gas fired, it, of course, created a considerable light in the neighbourhood. Murdoch being one of the members, there was no doubt, said Mr. Holcroft, that it was this circumstance that led to the manufacture of coal gas. The little narrative of the Chairman's was much appreciated. On behalf of the Association, Mr. Paterson acknowledged the hospitality which the Directors had shown throughout the day.

MANCHESTER INSTITUTION.

EXCURSION MEETING, MAY 3.

The Spring Excursion of the Institution was to Kendal; and although the town is almost at the extreme northern border of the extensive district covered by the rules of the Society, there was an unusually large turn-out of members. On arrival at Kendal, the members were met by the President (Mr. R. G. Shadbolt, of Grantham) and Mr. T. N. Ritson, the Engineer of the Kendal Corporation Gas and Water Works, and were at once driven to the Town Hall, where they were entertained at luncheon by the Mayor and Corporation. The Chairman of the Gas Committee (Mr. Alderman Monkhouse) presided; and he was ably supported by the Mayor, the Deputy-Mayor, and several other members of the Corporation. The courtesy thus shown to the Institution was cordially acknowledged by Mr. Thomas Newbigging, to whom was entrusted the subsequent toast of "Success to the Borough of Kendal."

Before leaving the Town Hall, the only formal business which is ever transacted at these excursion meetings was speedily got through. The Hon. Secretary (Mr. S. S. Mellor, of Northwich) read the minutes of the previous meeting; and they were confirmed. Thereafter, three new members were duly elected —Mr. Frank Barrett, of Ramsbottom, Mr. James Crook, of Kirkham, and Mr. Charles Potts, of Hyde.

Resuming their seats in the brakes, the members were driven to the gas-works, and an interesting half hour was spent in an inspection of the plant and machinery there—all fully described in a paper Mr. Ritson had thoughtfully prepared and had distributed earlier in the day (see next page). A still longer drive through lovely sylvan scenery brought the party to the new Fisher Tarn reservoir of the Kendal Water-Works, the main features of which (also described by Mr. Ritson in his paper) were closely scrutinized by the members. On returning to the Town Hall, tea was served; and after further acknowledgment of the obligation under which the Institution had been placed by the Corporation

and Mr. Ritson, for the admirable character of the day's programme, the proceedings ended, and the return journey (for those who had to leave the district) was made amid expressions of great satisfaction at the pleasurable nature of the outing.

The following is Mr. Ritson's description of

THE KENDAL CORPORATION GAS AND WATER UNDERTAKING.

Gentlemen,—First of all I must thank you for the honour you have conferred upon me in selecting the ancient borough of Kendal as the place for the One Hundred and Eighteenth Quarterly Meeting of our Institution; and, in the second place, I wish to accord you a very hearty welcome. Naturally, in a medium sized gas-works, such as Kendal, we cannot be expected to offer attractions in the shape of mechanical and labour-saving appliances, such as many of you are accustomed to, or have had the opportunities of seeing at the various large gas undertakings you have had the pleasure of inspecting from time to time. I trust, however, that what you may see in your tour of inspection to-day will be found interesting and acceptable. While we cannot boast of large gas and water undertakings, at the same time I believe you will find everything modern, and of a progressive nature.

GAS-WORKS.

The first undertaking for the supply of gas to the borough of Kendal was established in 1824, under the title of the Kendal Gaslight Company. Kendal was first lighted with gas on the 25th of July, 1825; the event being celebrated by general rejoicings and a public procession. The capital was £6000; and for further extensions it was increased to £7600. The works were transferred to the Kendal Union Gas and Water Company, who promoted a Bill in Parliament, which received the Royal Assent on the 26th of June, 1846, "for the purpose of affording a cheaper and better supply of gas light and water to the inhabitants of Kendal." The capital was then fixed at £30,000, with further power to borrow on mortgage or bond up to £10,000; and the shares of the old Company were merged in the new Company as preferential, and entitled to 7½ per cent. per annum dividend, with the option of conversion into ordinary shares, up to the 1st of January, 1851 (but which was never exercised). The undertaking was transferred to the Corporation of Kendal, under an Act of Parliament which received the Royal Assent on

the 20th of July, 1894. This Act authorized the borrowing of £142,625, divided into the following heads:—

For the purchase of the gas and water works	£80,000
To the old Company, for expenses on account of transfer	350
For redeeming the bonds of the old Company	5,350
For providing working capital	4,060
For stamping deed of transfer, &c.	440
For further extension of gas-works	21,000
For further extension of water-works	28,800
For expenses of Gas and Water Act (amount actually spent)	2,625
	£142,625

A legacy of £30,848 was received from the Executors of the late Alderman Bindloss (who was six times Mayor of Kendal) for the purpose of future expenditure on extensions and improvements of the water-works. This has been spent on the new Fisher Tarn reservoir.

The capital expended on the combined undertakings to March 31, 1899, is as follows:—

On gas-works	£61,904 5 10
On water-works	75,511 9 2
	£137,415 15 0

The present gas-works occupy an area of about 2 acres. The following table gives the progress of the works, at intervals, from 1846:—

Year.	Gas Made. Cubic Feet.		Price of Gas per 1000 Cubic Feet.				
			s.	d.	s.	d.	
1846	6,000,000	..	1846–1853		7	6	
1856	10,134,000	..	1854–1856		6	3	With discounts.
1866	19,289,500	..	1857–1864		5	0	
			1865–1871		4	2	
1876	26,106,200	..	1872		4	7	
			1873–1879		5	0	
1886	38,050,400	..	1880–1885		3	9	
			1886–1887		4	0	
1896	51,096,700	..	1888	3 9 &	3	6	
			1889–1896	3 6 &	3	4	
1899	61,541,000	..	1897–1899	3 3 &	3	1	
			Public lighting		2	10	

The gross profits of the combined gas and water undertakings have been as follows: 1856, £1773; 1866, £2426; 1876, £3057; 1886, £3507; 1896, £4313 (charge for first w.c. abolished; also half-year's gas-meter rents abolished); 1899, £5060 19s. 7d. (gas reduced 3d. per 1000 cubic feet).

RETORT-HOUSE.—The retort-house is 114 feet long, 60 feet wide, and 20 feet high to the eaves, and is capable of producing over 1 million cubic feet of gas per day. There are at present four settings of retorts built on Drake's generator principle (with subways), which contain 28 retorts, and four built on Hislop's regenerator principle (with subways), containing 28 retorts, with provision for 32.

COAL-STORE.—The coal-store, adjoining the canal, is capable of accommodating about 900 tons of coal; but an additional store is to be erected shortly.

CONDENSERS.—The condensers consist of six annular steel tubes, 20 feet high by 2 ft. 8 in. in diameter, and are capable of dealing with half-a-million cubic feet of gas per day.

ENGINE AND EXHAUSTER HOUSE.—In the engine and exhauster house are two combined engines and exhausters by Messrs. G. Waller and Co., of London, having a capacity of 20,000 cubic feet per hour each.

BOILER-HOUSE, BOILERS, AND FITTING-SHOP.—The boiler-house contains two Cornish boilers, 19 feet long by 5 ft. 6 in. in diameter, with gas-fitting shop overhead.

WASHER.—A Holmes's patent rotary washer-scrubber was erected in the autumn of 1895, and is capable of dealing with half-a-million cubic feet of gas per day. This washer completely purifies the gas from ammonia with from 10 to 12 gallons of water per ton of coal carbonized, leaving only 0·3 to 0·5 grain of ammonia in the gas at the outlet. Since this machine was erected, the yield of sulphate of ammonia has been more than doubled.

SCRUBBER.—The scrubber is 40 feet high by 5 feet in diameter, filled with wood grids.

PURIFIERS.—The purifying-house is 62 ft. 3 in. by 50 feet by 16 feet to the eaves, and contains six purifiers, 16 feet square by 5 feet deep, built on the overhead principle. These are capable of purifying half-a-million cubic feet of gas per day. The oxide revivifying shed is underneath; and the oxide is fed into the purifiers by elevating machinery.

METER-HOUSE.—This building, with the smith's shop and sulphate of ammonia store, has recently been re-constructed. The meter is capable of dealing with 20,000 cubic feet of gas per hour.

LIQUOR AND TAR TANKS AND PUMPS.—In addition to the underground tar and liquor wells, there are two overhead tanks, having a total capacity of 12,000 gallons.

GOVERNOR-HOUSE.—The governor-house contains two of

Wm. Cowan's patent equilibrium governors, fitted with Ritson's overflows. The gasholder valves are also in this house.

SULPHATE OF AMMONIA PLANT.—This plant is capable of making from 10 to 15 cwt. of salt per day.

CARBURETTER.—The carburetter is of the Price pattern; carburine or benzol being used for enriching purposes.

GASHOLDERS.—There are three gasholders, having a total capacity of 212,000 cubic feet. The heaviest day's consumption of gas last year was 336,000 cubic feet. It will be observed that the gasholder storage capacity is about 60 per cent. below the heaviest day's output. Powers are being obtained to acquire additional land to erect a 90-feet telescopic gasholder.

CHEMICAL LABORATORY.—There is a complete chemical laboratory fitted up, with a bunsen photometer by Messrs. Alexander Wright and Co., of London, together with apparatus for testing crude and purified gas, the material used in purification, bye-products, furnace gases, tar, &c.

MAINS.—There are about 20 miles of gas-mains; the trunk mains being 8 inches and 6 inches in diameter respectively.

UNACCOUNTED-FOR GAS.—The unaccounted-for gas has been reduced from 13 per cent. in 1891 to 5·85 per cent. in 1899.

CONSUMERS.—There were, on the 31st of March last, 1984 consumers on the books; and the total gas sold for the year amounted to 56,934,200 cubic feet, made up as follows:—

	Cubic Feet.	Per Cent.
1468 consumers by ordinary meters . . .	36,829,700 =	64·68
516 do. by prepayment do. . . .	2,881,500 =	5·06
284 ordinary street lamps and 74 high-power lamps	7,105,000 =	12·48
330 gas cooking-ranges	5,831,700 =	10·24
60 gas-engines	4,286,300 =	7·54
	56,934,200 =	100·00

Since the undertaking was acquired by the Corporation, gas-meter rents have been abolished, and the price of gas reduced 3d. per 1000 cubic feet. In the Water Department, the charge for the first w.c. has been abolished. In addition to the contributions to the sinking fund, amounting to £5203 10s. 2d., the reserve fund now stands thus: Gas, £2255 10s. 11d.; water, £1055 2s. 11d.; and there is the last surplus, amounting to £1104 18s. 1d., to deal with. In addition, £500 was given last year towards relieving the rates, due to the disastrous flood on the 2nd of November.

ELECTRIC LIGHT.

Preparations are being made to obtain powers to erect an electric lighting station upon the site of the gas-works, and to be worked conjointly with that undertaking.

WATER-WORKS.

The water supply at present is partly gravitation and partly pumping. The gravitation works consist of two reservoirs at Bird's Park. The lower reservoir is 400 feet above Ordnance datum. Its construction was commenced in 1846, and completed in 1848. The upper reservoir is 464 feet above Ordnance datum. It was constructed in 1856. The drainage area comprises about 210 acres. The capacity of both reservoirs is about 18 million gallons, which is altogether out of proportion to the gathering-ground and requirements of Kendal. The pumping plant at Mints Feet was constructed in 1869-70. It consists of two of Cameron's direct double-action ram-pumps; and steam is supplied from two Lancashire boilers. The pumps, when at work, deliver daily about 250,000 gallons of water direct into a 6-inch main, which joins the 8-inch main from the lower reservoir. In 1892—when I took over the gas and water undertaking—the consumption of water was between 35 and 40 gallons per head of the population. In 1894, steps were taken to overhaul the mains, service pipes, and consumers' fittings; Deacon's differentiating waste-water meters being introduced, to aid in localizing and detecting underground or hidden leakage and waste. Since the commencement of operations, some 250 defective service pipes have been renewed, and numerous defects in mains remedied, together with innumerable repairs to consumers' fittings and apparatus. The stoppage of one single leak in a main increased the pressure in the particular district by 50 lbs. per square inch. The stoppage of these leaks has materially improved the supply of water to the town; and the result has been a saving of £450 to £500 a year in pumping charges. The consumption of water at present is as follows: High-level service supply, 17 gallons per head of the population; low-level service supply, 25 gallons per head of the population—equal to a daily consumption of 331,000 gallons. When the Fisher Tarn reservoir is complete, the pumping-station will be discontinued.

MAINS.—There are about 25 miles of water-mains, the trunk mains being 8 inches and 6 inches in diameter respectively. The following figures show the increases in the water-rental at intervals from 1856: 1856, £791; 1866, £1283; 1876, £1842;

1886, £2570; 1896, £2767 (charge for first w.c. abolished); 1899, £3085.

RAINFALL.—The average rainfall for the past forty years has been 51·02 inches.

THE FISHER TARN RESERVOIR.—This reservoir has been designed by Mr. G. F. Deacon, M.Inst.C.E., of London, who has also acted as responsible Consulting Engineer for the work; the position of Resident Engineer having been ably filled by Mr. J. H. Parkin, Assoc.M.Inst.C.E.

The reservoir, which was commenced in July, 1895, is situated about 742 feet above Ordnance datum, and occupies an area of 31 acres; the capacity being 120 million gallons.

The dam is 407 yards long, and was the first of its kind constructed in this country; the foundations from the ground-level to the solid rock being composed of lias lime concrete, while the superstructure is built in solid masonry laid in lias lime mortar. The greatest height of the dam, at the bye-wash, is 44 ft. 6 in.; and the width varies in accordance with the height of the earthern embankment which extends for the greater part of the length of the dam.

Provision for dealing with the flood water is by means of a bye-wash formed in the masonry work of the dam, which is suitably ornamented by turrets on each side. The parapet of the dam is 6 ft. 8 in. wide, and is formed of concrete blocks.

The stone, which is of the Silurian formation, was obtained from a quarry upon the site. Blake and Marsden machines were employed to break and crush the rock into macadam; and suitable pulverizers and rolling mills were used for making the sand employed for concrete. The best and largest stones were dressed for the facework. The lias lime, after being slaked, was passed through a mortar mill, and afterwards ground to a fine state in a "Burr" stone mill, from whence it was conveyed automatically to the store tank before being measured into the concrete and mortar mixers.

The water is drawn off by means of a telescopic tube connected to a float, so arranged that the water is always taken a few feet below the surface.

In the valve-house, at the foot of the bye-wash, are fitted the outlet and scour pipe-valves; also apparatus for regulating the compensation water (which is fixed at 60,000 gallons per day), and a Deacon differentiating meter for measuring the supply.

The area of the natural gathering-ground is about 160 acres; but an intercepting drain has been laid so as to tap another 80 acres, and also some 50 acres of the Bird's Park gathering-

ground. The total gathering-ground of all three reservoirs is about 450 acres.

A 15-inch main will convey the water to the present reservoirs, where it is contemplated to erect filter-beds. Provision has been made in this pipe-line, so that advantage may be taken, if so desired, of the water power available to generate electricity by means of turbines erected near Bird's Park lower reservoir.

Impounding commenced on Feb. 2, 1899; and at the end of May there were some 70 million gallons of water in the reservoir.

The dam is practically finished; and it is expected that the whole of the work will be completed in three or four months.

NORTH BRITISH ASSOCIATION.

ANNUAL MEETING, JULY 27 & 28.

This Meeting was held in the Albert Hall, Stirling. There was an attendance that was probably the largest witnessed at any meeting of the Association, which was most likely due to the fact that there was to be an exhibition—for the first time out of London—of Keith's automatic air and gas compressors; the programme being otherwise an extremely light one. Mr. HUBERT POOLEY, of Dunfermline, the President for the year, occupied the chair.

WELCOME TO THE TOWN.

The PRESIDENT said they had with them Mr. W. Johnstone, the Chairman of the Stirling Gaslight Company, to whom they must give a hearty welcome, as the kindness of the Company to the Association had been very great.

Mr. JOHNSTONE said he was glad to meet the members, and wished to be allowed to say, in the name of the Stirling Gas Company, that they were much gratified that the Association should see fit to visit Stirling again. Since their last meeting there, the Company had passed through some anxious experiences; and had the Association come there a year or two ago, he was not sure that they might not have looked upon them with some suspicion. But they were now in a position of confidence, and heartily welcomed them to the Royal Burgh. Instead of closing their gates against them, they invited them to go and see their works; and if anyone had any suggestions to make, they would be thankfully received and carefully considered. He had had an opportunity, the previous day, of seeing Mr. Keith's process of intensifying gas, and he believed that, where it could be conveniently applied, electric light would not compare with it, either for brilliancy or for cheapness. He considered it would be very much of a prize to them.

THE COMMITTEE'S REPORT.

The SECRETARY (Mr. R. S. Carlow, of Arbroath) read the report of the Committee. It set forth that the benevolent fund

in connection with the Association had been drawn upon to the extent of £23 in the past year; three amounts having been paid to two deserving cases. The sum of £11 12s. 10d., being the balance at the credit of the Murdoch Memorial Fund, which was handed to the Secretary at the last annual meeting, had, by instructions of the General Committee, been placed to the credit of the Research Fund. The Murdoch Memorial Fund account was now closed. The correspondence during the year with the Council of the Gas Institute upon the subject of the standardizing of meter-unions was next given, concluding with the return of the set of standards the Association had lent, and which the Council had examined with great interest. The report then proceeded as follows:—

This letter was fully discussed, and, after consideration, the Secretary was instructed to call the next Committee meeting in Edinburgh, and to invite the Edinburgh meter makers to be present at the meeting, in order that the Secretary of the Gas Institute's letter might be fully discussed with the Committee of this Association, and an understanding arrived at, and a joint report drafted for submission to the annual meeting. On July 5, 1899, your Committee met in Edinburgh, and the meter makers were all invited to attend the meeting. All the meter makers in Edinburgh sent representatives to the meeting. The position of matters was fully discussed between the meter makers and the Committee of the Association, when the following finding was arrived at: "As the result of a discussion of the question of standard unions, it was deemed inadvisable to further press the question of the adoption of the standard meter-unions provisionally approved; but, with the view of removing the practical difficulties arising from slight variations in the pitch or diameter of screws now in use throughout Scotland, the meter makers undertook to institute a careful comparison between the unions presently in use, and mutually adjust, if possible, such difference as may exist, so as to ensure that the unions of the various makers be uniform and interchangeable."

The report concluded by stating that the Committee unanimously recommended that the name of Mr. Peter Watson, late of the Stirling Gas-Works, should be added to the list of honorary members, as he had been for so many years connected with the Association.

On the motion of Mr. T. WILSON (Coatbridge), seconded by Mr. W. EWING (Hamilton), the report was adopted.

Mr. P. WATSON briefly thanked the members for electing him an honorary member of the Association.

NEW MEMBERS.

The following were admitted to the Association:—

Ordinary Members.—Angus, J., Wigtown; Blair, P., Haddington

Forrest, R., Birnam; Galloway, J., East Wemyss; Keillor, G., jun., Peterhead; M'Donald, J., Aberlour; Smith, A., Airdrie; Smith, J. D., Stirling; Watson, P. B., Stranraer.

Extraordinary Members.—Hamilton, A. H., Glasgow; Marks, T., Glasgow; Munn, A., Glasgow; M'Kenzie, A., Edinburgh; Peebles, W. C., Edinburgh.

Associate.—Dickson, J. Forfar.

Honorary Member.—Watson, P., Stirling.

The Annual Accounts.

Mr. R. B. Main (Glasgow) the Auditor, submitted the accounts of the Association for the year. They showed the following sums: General Fund, £153 12s. 9d.; Benevolent Fund, £259 10s. 3d.; Research Fund, £100 0s. 2d.; Excursion Fund, £111 19s. 2d. There were also the following cash balances: General Fund, £50 14s. 7d.; Benevolent Fund, £226 1s. 8d.; Research Fund, £30 18s. 2d.; Excursion Fund, £20 6s. 2d.

The accounts were approved; and a vote of thanks was accorded to Mr. Main.

The President's Address.

The President then delivered the following

INAUGURAL ADDRESS.

Gentlemen,—My first duty to-day must be to thank you very heartily for the honour you conferred upon me by electing me your President at the last meeting. It is six years since I joined the Association as a stranger from over the Border; and I must say that from the members of the Association in the North I have received nothing but kindness. I am one of the younger members of the Association, and of the profession; and in addressing you to-day I do so with considerable diffidence—mainly owing to the fact that I have, unfortunately, to follow the exceedingly able addresses very recently delivered before the Gas Institute and the Institution of Gas Engineers. The technical press has made us all familiar with them. I must, therefore, crave your indulgence, and ask you to kindly bear with me.

We have now had a full year's experience under the Workmen's Compensation Act; and, so far, it would seem to have principally benefited the Insurance Companies. This questionable benefit has directly resulted in a great increase of rates. For example, the rates at Dunfermline, which were formerly 2s. per cent. on the wages paid, were at once sent up to 9s. per cent. Latterly, in some directions at any rate, insurance people seem inclined to considerably modify their views on the subject;

and I have recently had a quotation of 5s. per cent. from one of the leading offices.

Growth and progress have of late years, happily, entered into almost every phase of our national commercial life; and the industry in which we are all so much interested, has during the past year naturally shared in this prosperity. In comparing our latest gas statistics with those of the previous year, I find that the gross increase at Scottish gas-works has amounted to about 343 million cubic feet of gas. But while our makes have increased, coals have been dearer; and those of us who have not already purchased, will find that they are to be much dearer still. This is a penalty which, in common with other manufacturers, we have to pay for a widening area of prosperity. We are all likely to benefit from the increased price of residual products. Coke commands a good price, and has a ready sale; and, with the present good price of sulphate of ammonia, tar and liquor should show an improved return.

The relations between capital and labour have, for the most part, been amicable; and concessions have been given to the working man in many cases.

Competition with our friends the electricians still continues; but I am glad to say gas more than holds its own. There have been several cases where the old snuffed-out gas has been reinstated, and the newer light displaced; one notable case being that of Sandringham, the Prince of Wales's residence in Norfolk. The development and the practical application of "intensified gaslight" has put into our hands a cheaper means of obtaining a better light than anything which has yet been brought out electrically, in the way of either arc or incandescent electric lighting; and we shall have shown to us, later on in the day, a practical illustration of a type of plant for obtaining this magnificent light. This light will lend itself principally to the lighting of large interiors or open spaces, and for street lighting. Examples of incandescent street lighting by the ordinary burner are familiar to all of us. In Dunfermline, there are in use some 54 burners, which, during the year, cost for repairs the sum of £19 16s., equal to 7s. 4d. per lamp. They required 250 mantles, 15 globes, 154 rods, and 2 small inside globes. The average gas consumption in these lamps for the year was 8800 cubic feet in the "all-night" lamps, and 2150 cubic feet in the "half-night" lamps.

With regard to the lighting of factories and other similar undertakings where the rapidity of the moving machinery is liable to set up continuous excessive vibration, it has been

clearly proved that incandescent lighting can be adapted to such conditions. I have had one striking case in my own town. Since the Corporation took steps to acquire the gas undertaking in 1896, there had been talk of introducing the electric light into one of the linen factories; and, as I was naturally anxious to show the proprietors of the factory something of the possibilities of gas, I made efforts to place a few experimental incandescent burners, but only succeeded in getting them into the offices. At length a firm manufacturing anti-vibration apparatus took the matter up, and succeeded in placing some fifty burners in the power-loom factory. Vibration on the gas-fittings was very heavy and continuous; and I confess I had some misgivings as to the ultimate success of the experiment. Ten weeks after the fixing of the burners, on calling at the factory, I found that up to that time they had not needed to renew a single mantle. The result to the consumer was a saving of fully 27 per cent. in the gas bill for the year, although the factory was only partially lighted by the incandescent system, and that for only part of the season. I have no doubt that next season we shall have the whole of the buildings lighted in this way, and there will be no further mention of electricity.

Another of our competitors, acetylene, has found great favour in some directions; but most of those who have adopted it as a means of public lighting have learned a bitter lesson. I was called in during the year to advise a company manufacturing oil gas as to the best means of providing an illuminant for a town of about 6000 inhabitants; and I was specially requested to report on the *pros* and *cons* of acetylene for the purpose. In estimating for the supply of acetylene, I found it very difficult to obtain reliable information as to supplies of calcium carbide over a lengthy period, and likewise as to its cost. On going thoroughly into the question in all its bearings, and especially as the works are situated in the centre of a very extensive coal-field, I reported against its adoption. Notwithstanding this, the Directors determined to go in for an installation. The costly experiment continued for a few weeks only; and the Company were forced to abandon their position and return to oil gas. It is interesting to chronicle here that the charge made for the gas was at the rate of £5 per 1000 cubic feet. Probably the principal cause of failure—apart from the prohibitive cost—was the use of burners which were not suited to the conditions generally. Shopkeepers and others made complaint of sooty deposits, and gave up the use of gas entirely. It is almost

unnecessary to say that very considerable trouble was experienced in collecting the gas accounts.

At Dunfermline, for the year ending May 15, 1899, we have had an increase of 3,661,300 cubic feet in the sale of gas over the previous year; and this increase has been largely due to the use of prepayment meters, and also to the introduction of a differential rate, of which I gave some particulars at the meeting held in Ayr two years ago.* I am now in a position to give some details of the working of the system during the past two years, first of all comparing the consumption with prepayment meters since their introduction in 1893-4—

Year.	October. Cubic Feet.	January. Cubic Feet.	April. Cubic Feet.	Annual Total. Cubic Feet.
1893-4	—	900	1,400	2,300
1894-5	58,200	65,600	65,100	188,900
1895-6	96,900	146,300	158,200	491,400
1896-7	221,200	395,300	324,200	940,700
1897-8	351,800	895,000	739,600	1,986,400
1898-9	771,500	1,823,100	1,367,500	3,962,100

You will notice that this is a repetition of the "same old story," which shows immense growth in this class of business. In our case, we have practically doubled each year since we commenced. I do not find in any of the statistics published in reference to the working of prepayment meters and free cookers in connection therewith, that any figures have yet been given for Scotland. The following may, therefore, be of interest: During the last year we had fixed in Dunfermline, for the full period, 111 prepayment meters, to which free stoves were attached, and 359 prepayment meters without stoves. The average consumption per meter was 8786 cubic feet in the former case, and 5761 cubic feet in the latter; showing that an additional consumption of 3025 cubic feet, or 52 per cent., was due to the stove. I find that, as a rule, the class of consumer using the stove does not appreciate the oven nearly so much as the boiling burner on the top of the stove; and in many cases the oven is never used at all.

The consumption under the heading of a differential rate (that is, a special rate for heating, cooking, and motive power purposes) has been, since its introduction two years ago—

Year.	October. Cubic Feet.	January. Cubic Feet.	April. Cubic Feet.	Annual Total. Cubic Feet.
1897-8	1,766,300	1,344,200	1,419,200	4,529,700
1898-9	3,081,800	1,825,000	1,847,800	6,754,600

A great deal has been said lately for and against the system

* See "Reports of Gas Associations" for 1897, p. 163.

of a differential rate. In our case, it has proved an unqualified success; and my most sanguine hopes have been fully realized. At the time of its introduction, gas for lighting purposes was sold at 3s. 7d. per 1000 cubic feet; while coal was retailing at 10s. to 11s. per ton. Our interest and sinking fund charges were high; and had we been obliged to pay the latter, they would have amounted to over 1s. 10½d. per 1000 cubic feet of gas sold. It was, therefore, absolutely necessary to do something to obtain additional business; and in a one-trade town, with that trade in an unsettled state at the time, the development of prepayment meters and the adoption of a differential rate seemed the only possible openings for new business. With the increased consumption of gas, the figure for interest and sinking fund charges has been reduced to a trifle less than 1s. 7d. per 1000 cubic feet sold.

Our Association have, unfortunately, to record the loss of several members during the year. Death has removed some from our ranks; while others have discontinued their membership. But I am glad to be able to note accessions, which have, notwithstanding the losses, brought up our membership to a numerical strength in excess of that of last year. I trust that the new blood introduced to-day will add to our vigour as a real live Association. It may, perhaps, not be out of place if I mention here a difficulty felt almost every year by your Committee. I refer to the difficulty we have experienced in obtaining volunteers for the work of submitting papers. May I here ask the members generally, and particularly the junior members, to do what they can to lighten this part of the Secretary's work. We owe a great deal to the energetic way in which he carries on the business of the Association; and I am sure he would appreciate it very much if, by way of a change, a few papers had to be declined, owing to the shortness of time at the Committee's disposal for the annual meeting.

Gentlemen, we are to have a valuable lecture and a paper submitted to-day; I will not, therefore, trespass further upon your valuable time.

Mr. T. WILSON said he was sure the members were all much indebted to Mr. Pooley, their worthy President, for his address. He personally was exceedingly sorry that it was a presidential address, because he should have liked to go into some of the figures contained in it. But they must take it as it had been given; and he had much pleasure in moving a hearty vote of thanks to Mr. Pooley.

This having been accorded,

The PRESIDENT said he was very much obliged to the members for the manner in which they had received his address, and for the cordial vote of thanks they had passed to him.

Mr. A. YUILL (Alloa) then read the following paper:—

ARTIFICIAL LIGHT, WITH SPECIAL REFERENCE TO GAS AND ELECTRICITY.

The circumstances under which we live are much altered since the time when the curfew bell warned all loyal people to extinguish their lights and fires at eight o'clock in the evening. The simple lives and habits of our forefathers called for no more labour at their hands than could be accomplished between sunrise and sunset; so that artificial light was to them a matter of secondary importance. But all is now changed. We no longer consider that our day's work is over when darkness comes upon us; indeed, a large proportion of the population are more busy during the night hours than at any other time. Hence the possession of some reliable and effective means of procuring artificial light becomes almost as much a necessity to us as our daily bread.

The question may be asked: How was the first light obtained? Those who have travelled and come into contact with aborigines tell us they have been initiated into the mystery of obtaining light by friction, through rubbing two sticks together—a task easily accomplished in the hands of native Africans and Indians at the present day. In the hands of the chemist, light can be produced by much more simple means. In the far northern regions, the only source of light obtainable is the oil or fat got from the seal or walrus, which is burned in cruses, and which was much in evidence in our own country a century or two ago. Perhaps some of you may remember, or have seen in some rural district, three or four decades ago, a primitive method of obtaining light by placing a piece of gas coal on the front hob of the grate, which often supplied all the light that was required. Candles and oil lamps were the principal sources of light available until the beginning of the present century, when gas was first introduced. Its adoption met with great opposition; and lectures in all parts of the country proclaimed the direful effects that would follow its introduction. The antagonistic feeling thus aroused may be compared to the strong prejudice previously evinced against the use of coal as a fuel.

In the production of artificial light there are two methods by

which it may be obtained—(*a*) by the combustion of matter or elements; and (*b*) by the incandescence of matter or elements. We have an example of combustion by the burning of coal, wood, gas, or any carbonaceous material, which invariably undergoes a change of form. We have an example of light from incandescence by the caloric power of any gas impacted or impinging against any of the alkaline earths, or by a current of electricity passing through a platinum wire, which offers resistance to its passage, or through a filament of carbon enclosed *in vacuo*.

The main essential in the combustion of any combustible material is oxygen, which may either exist in the gaseous state or in combination with the combustible material, such as gunpowder, nitro-glycerine, or any explosive compound. Knowing the part which oxygen plays in the development of combustion, we can better understand the genesis of flame. There are few phenomena in Nature so wonderful as the flame of a candle, oil-lamp, gas, or the burning of coal in our fireplaces. Yet who pays any particular attention to them? Very likely that familiarity, which is responsible for so much neglect, may also account for this indifference. In the study of a gas-flame we are confronted with a more complex compound. It is a mixture of several gases; but an ultimate analysis of it would show the component parts to be principally carbon and hydrogen, which, in combination with the oxygen of the atmosphere, burn to carbonic acid gas and water.

Notwithstanding all the wondrous achievements of the ancients—their magnificent monuments and buildings, their sculpture, their pottery, and their knowledge of many valuable arts, which have long since been lost—they appear to have been totally unacquainted with the existence of gases. The first recorded instance of the production and storage of a gas is that given by the Hon. Robert Boyle, who experimented on hydrogen gas by dissolving pieces of iron in an acid. The evolution of the production of the "spirit of coal," as it was then termed, passed through many vicissitudes and many decades. But there was still wanting the master mind to suggest the means of carrying it into practical operation by storing the gas, and conducting it through pipes to any place that might be desired, to give light and heat. The difficulty was solved by a Scotsman—William Murdoch—in recalling the honour paid to whose memory (the last time we met in Stirling, a few years ago) we all take a pleasurable delight.

Of all the improvements that the active march of scientific research and enterprise has called forth during the last half

century, that brought about by the continually increasing demand for artificial light is by no means the least prominent. The whole facts of the case, however, are not covered by the simple assertion that there is an increasing demand for artificial light. The progress of science and enterprise has also brought with it increased competition. Trade expenses are watched and scrutinized with a care and acuteness that are also continually increasing, with a view to bringing them down to the lowest possible point of economy. The gas account, which was formerly passed for payment as an unavoidable charge, like the poor-rate or income-tax, is now carefully checked and examined to see whether similar lighting effects could not be obtained by other methods at less cost.

For many years after the first introduction of gas lighting, the apparatus generally employed differed somewhat from that found in well-equipped works at the present day; but as the improvements made are now so well known to the members of the gas profession, I am saved the necessity of particularizing them. No matter how well equipped individual works may be, the gas engineer of to-day has still the same difficulties to contend with as those experienced by his predecessors in the past. With reference to internal fittings of houses, I fail to see why local authorities are so anxious to have every detail connected with the sanitary arrangements of a house arranged in such a way as to render escapes of sewage matter almost impossible, while they overlook (or fail to supervise) the internal gas-fittings of houses. I am of opinion that Gas Associations ought to raise the question and bring it prominently before the Sanitary Congress, with the view of having all gas-fittings in houses properly tested and of ample size before occupancy.

No doubt it will be the experience of many of the members to be called upon at times to advise as to the most economical method of lighting by gas. A great many factors enter into this at the outset; but in considering the best type of burners, I unhesitatingly recommend the newer form of incandescent gas-burner, as from it the consumer gets the maximum amount of light at the minimum of cost. One source of defective light, when ordinary burners are used, is in the liability to forget that they are getting old. It has been my experience in some cases that the consumer could not remember when the burners were changed. They imagine that, like Tennyson's brook, they "go on for ever." To get the full advantage of the gas consumed from ordinary burners, the consumer ought to be advised to have them changed at least once a year.

Another cause of complaint is due to the form of globes used, obstructing, as some of them do, from 5 to 50 per cent. of the light. Globes, in my opinion, have only one object to serve apart from the æsthetic or decorative point of view—that is, to prevent cross currents of air from chilling the flame and thereby preventing the illuminating matter from being fully utilized. Globes with narrow openings at the bottom should not be used. Should anyone be desirous of placing himself in a position to complain regarding the illuminating power obtained, I would advise him to get an old burner that has been in use for a good number of years, and cover the flame with a ground-glass globe with a small opening at the bottom and with a profusion of flowers painted thereon, when, no doubt, he will get the object of his desire.

The continued prosperity of the gas industry is a matter for congratulation, especially at the present time, in view of the enormous amount of lighting now being done in the principal towns and cities of the United Kingdom by our firmly-established competitor, the electric light. On the face of it, it would seem almost incredible that these numerous electric lighting companies can go on increasing their business so enormously as they are doing—taking over, to some extent, the cream of the gas consumers—without affecting in the least the ever-increasing demand for gas. That the advance of electricity has so little effect upon gas sales cannot be other than a source of great satisfaction, more especially in towns where the gas supply is in the hands of the local authority. The electrician will doubtless go on effecting improvements that will gradually reduce the cost of the electric current; and it is scarcely necessary for me to say that we who make gas are equally determined to follow the same aim, and bring about the same results in our sphere. We have much to encourage us in the study of incandescent gas lighting and other developments in various directions, which prove that gas is almost as much in its infancy as is the generation of electricity. In proof of this let us take the make of gas in the United Kingdom. From statistics published by the Board of Trade relating only to gas corporations and incorporated gas companies, we find that in 1887 90,000 million cubic feet were manufactured, whereas in 1897 132,000 million cubic feet were made—an increase of 42,000 million cubic feet, or 46 per cent. more. This increase may be best shown by taking the monetary value of the increased quantity produced at a rate of 2s. 6d. per 1000 cubic feet, which would represent a sum of not less than

£5,250,000 paid for gas in 1897 in excess of what was paid ten years previously. The total amount of gas made in the United Kingdom by gas companies and corporations last year was 140,600 millions, representing a monetary value of £17,575,000 at 2s. 6d. per 1000 cubic feet.

Acetylene gas, which was so much in evidence a few years ago, was known to scientists as far back as 1836. But it was only in 1894 that a new and cheaper method for the manufacture of calcium carbide was discovered. A great future was predicted for this gas; but it has failed to establish itself, because of its costliness. In isolated districts, or where the cost of gas is high, it may prove its usefulness; but great precautions require to be taken in storing calcium carbide, as it is now ranked as an explosive, and placed in the category of inflammables.

Wonderful as the present century has been in all that pertains to the development of science, the twentieth century promises, in one respect, to surpass it. The present century may be considered as the triumphant period of the civil engineer—the Alexander of modern times, who has so little to conquer. Some consider that the twentieth century will be the apotheosis, so to speak, of the electrical engineer and of his scientific brethren who engage in the investigation of electricity and ether.

Naturally the question presents itself: "What is electricity?" That it will be answered within the next few years is certain. The advance of electrical science enables us to arrive at a very shrewd and close definition respecting this agent. It surrounds us (it exists in our bodies); is in or upon everything. It cannot be produced by any human agency. It is——well, we can say no more. Although we may not be able, satisfactorily, to give a definite answer of what electricity is, still we can demonstrate how it may be produced and saddled for our requirements and uses. In the generation of electricity, three modes of power may be used: (*a*) steam-engines; (*b*) gas-engines; and (*c*) natural forces. The last may be subdivided into two classes: (1) water power, (2) wind power. [Since these lines were written, I have been informed that it can be obtained from other sources—by heat.]

In large installations, where a considerable electro-motive force is required, steam-engines may be said to be the best power; but in small installations, or where the electric current is generated for private use, gas-engines are the most economical. In positions conveniently situated, water power may prove economical; but I cannot help remarking that this available power is considerably over-rated by some. It is generally

looked upon as a safe rule, in calculating the power of water, that 1 cubic foot of water falling 15 feet per second will give 1 electrical horse-power per hour.

The two recognized systems of electric lighting are the arc and the incandescent. Perhaps it will be known to some of you that electricity, in the form of the arc light, was discovered by Sir Humphry Davy about 100 years ago; so we must not imagine that "the light of the future" is a child of yesterday, as some term it. The arc light is by far the cheapest mode of electric lighting, when the intensity of the light is taken into account. This must necessarily be so, as the arc light is obtained from the incandescence produced by the combustion of the carbon, caused by the flow of electricity between the carbon points. The light from the incandescent lamp is obtained from the heat of the carbon filament—no combustion of the carbon taking place. In fact, most of the electrical energy passed through an incandescent lamp is converted into heat and not into light; hence the reason that the one is more expensive than the other. If we take the electrical power required to give an effective light of (say) 800 candles with arc and incandescent lamps, the approximate power would be, for an arc lamp of, say, 800 effective candles, ½ to ¾ horse power; while for incandescent lamps to give an aggregate light of 800 candles (fifty 16-candle power lamps), 6-horse power would be required. Thus 1-horse power would give 160 candles by using incandescent lamps, and it would give 1200 candles by using an arc lamp.

It is a recognized fact among gas engineers that the gas, as ordinarily consumed, gives a very small percentage of light from the percentage of carbon it contains. The potential energy stored in the gas is largely converted into heat; in fact, it is from this transformation of energy into heat that any light is obtained. Heat and light go hand-in-hand; and the investigations of some gases have shown that curious anomalies exist, which are worthy of study by scientists. The light obtained from gas by an ordinary jet gives almost the lowest percentage of illuminating value compared with any other system. If we take gas of (say) 25 candles, it would give, with an ordinary jet, an illuminating value of 5 candles per cubic foot; but if consumed with the new form of incandescent burner, 25 candles per cubic foot of gas would be obtained. In fact, in this form, they claim 30 candles per cubic foot. But suppose that, instead of consuming the gas, we convert the potential energy into electrical energy by means of a gas-engine of (say) 10 effective horse power. This engine would require (say) 20 feet of gas

per horse power per hour, or 2000 cubic feet in all. This power would be capable of supplying electrical energy for (say) 15 arc lamps, each giving 800 candles effective, or a total light of 12,000 candles, equivalent to 60 candles per cubic foot. Were the gas consumed in the ordinary way, by the use of ordinary burners, 1000 candles only would be obtained. In making these comparisons, allowance must be made for the interest and depreciation of the electrical plant, together with the cost of making, which I have no doubt would equal, if not surpass, the cost of obtaining equal lighting value by using the new form of incandescent gas-burner.

In making a calculation as to the total gas made last year in the United Kingdom, I find that the respective countries stand as follows:—

	Cubic Feet.	
England	125,000,000,000	or 88·15 per cent.
Scotland	11,700,000,000	„ 8·32 „
Ireland	3,900,000,000	„ 3·53 „
Total	140,600,000,000	100·00

To show the gigantic importance of the gas industry to the coal trade, it may be mentioned that over 14 million tons of coal are required every year.

In dealing with electricity, last year the following statistics were furnished to the Board of Trade:—

	Local Authorities.	Companies.	Total.
Capital	£5,021,399	£6,884,764	£11,906,163
Revenue	£603,768	£881,027	£1,484,795*
Units sold . . .	35,319,543	40,814,688	76,134,233
Kilowatt capacity .	53,238	59,053	112,291†
Horse power‡ . .	71,364	79,160	150,524
Lamps fixed. . .	2,090,232	2,544,191	4,634,423

* Price equal to 4·68d. per unit.
† Equal to 3,743,033 8-candle power lamps.
‡ Calculated at 746 kilowatts per horse power.

It is generally considered that 80 cubic feet of gas are equal to 1 unit of electricity; and this, multiplied by the total units of electricity sold, represents 6,090,738,000 cubic feet, or 4·33 per cent. of the quantity of gas made per annum, which amounts to nearly the average annual increase of gas companies. That is, taking the total output of both, we have gas displaced which only amounts to 4·33 per cent. of the total gas made.

One thing in considering the above statistics from a comparative point of view is the capital required by electrical companies

and local authorities in comparison with their output. We find that they require £11,906,163 to produce 76,134,233 units; and from the above calculation it will be seen that this quantity is equivalent to 6,090,738,000 cubic feet of gas. Taking £500 per million cubic feet as capital expenditure for new works, the above quantity of gas could be dealt with by an expenditure of £3,045,369 against £11,906,163, by electrical companies, which tells greatly in favour of gas undertakings.

A good deal could be said in comparing gas and electricity; but the length of this paper, and the short time I have had for its preparation, form a sufficient excuse for bringing my remarks to a close.

Discussion.

The PRESIDENT said they had had a most interesting paper from Mr. Yuill, setting forth the relative values of gas and electricity; and he invited remarks or questions upon the paper.

Mr. J. M'GILCHRIST (Dumbarton) thought that Mr. Yuill's paper was more of the nature of an address than of a paper to be discussed. He looked upon it as most interesting; but, if he might be allowed to tell them a story, it reminded him of the Irishman who, when he went to Niagara, saw the water coming down, and, on being asked if he were not surprised, replied that he was not, that he would be surprised if it were the other way. So, he thought, most of them would be surprised at Mr. Yuill saying so much in favour of gas. Really, it was too bad. He thought that Mr. Yuill might have said a kindlier word for the electric light. It had come to stay; there was no mistake about that. In regard to other modes of lighting, he (Mr. M'Gilchrist) did not think they were of so much account; but in regard to electricity, he thought that they, as gas managers, should not make too light of it.

Mr. A. MACPHERSON (Kirkcaldy) was sure Mr. Yuill had given them statistics in the paper by which, when they came to study it, they would profit much. Unlike Mr. M'Gilchrist, he could not say that Mr. Yuill had been, what he might say, hard on the electric light. He had, in his opinion, stated the bald facts, and compared the light which could be produced by electricity, and the cost of producing the light, with what could be got from gas, burned in the various ways in which it was now consumed. In this, he (Mr. MacPherson) thought that Mr. Yuill had done a very wise thing, because it showed them that, however much, and however loud, the noise made about the electric light, gas was not only holding its own, but was still progressing, and he

had no doubt, even though the electric light (as Mr. M'Gilchrist said) had come to stay, that from it they had nothing to fear, in the matter of the consumption of gas improving. He could only say that, so far as their experience had gone in the past, that the electric light had been a great friend to gas people. It caused a demand for more light, and those who could not get the light from electricity, naturally fell back upon the cheaper, and, he would not say better, but equally serviceable, gas light. In this way it had, he thought, considerably increased the consumption of gas; so that it had really done them a friendly turn. But not only so; it had also urged them forward. He was not such a very old man; but he was old enough to remember that for years gas engineers rested on their oars and did nothing. They supplied gas, and it seemed immaterial to them whether the consumers received the full benefit of the gas or not. Now things were changed. A great many people had set themselves to solve the problem of how to make gas cheaper and better, as an illuminant, than the electric light. In this way not only had they benefited gas managers, but they had made them take a more direct interest in the light which the consumer received from the article which they supplied; thereby, to a very considerable extent, benefiting the consumers of gas also.

Mr. W. Briggs (Dundee) remembered years ago discussing the question of electricity *v.* gas with one of the members of the Association, who said to him that electricity never would compare with gas, because of two facts—the one that it could not be stored, and the other that if the light were cut off from a portion of a building, it would be cut off from the whole. Now, they knew that these difficulties had been overcome; and he was very glad to hear the observation that they should not treat electricity with disdain.

Mr. T. Wilson (Coatbridge) wished to corroborate the remarks of Mr. Yuill; and it might not be uninteresting to give them the history of an Electric Light Company in the town of Coatbridge. Some years ago, a House-to-House Electricity Company applied to Parliament for powers to put down an electric installation, in opposition to the Gas Company—incorporated by Act of Parliament. He, as an individual, and as representing the Gas Company, opposed the application. Counsel for the promoters asked what he was present for. He replied that he was Manager and also Secretary of the Coatbridge Gas Company. The Chairman of the Committee thereupon said: "Then you are here for a selfish motive." He said: "I beg your pardon, I am here trying merely to get fair play. I think it is scarcely fair that Parliament

should, in 1877, grant power to a local Gas Company to spend £50,000 for the purpose of lighting the district, and should now grant powers to a foreign company to come in and snuff us out." The Chairman took his view of the matter; but they were not successful, and powers were granted to the Electricity Company. They put down plant which cost from £26,000 to £30,000, and things looked blue for the Coatbridge Gas Company. They were then making about 60 million cubic feet of gas a year. Well, the plant which the Electricity Company put down was not suitable, and was replaced by other plant. That, in turn, proved to be quite as unsuitable; and they had it replaced again, and he believed they had not, even yet, a model installation of electricity in Coatbridge. He was sorry for the Electricity Company, but it was the fact that the community had not taken advantage of its services. They had very few customers, and they were struggling hard to keep things going. There was no doubt that this year they would have a big loss, as they had last year. They did not do the Gas Company much harm by the ordinary consumers they took over; but they had brought the matter under the notice of the ironmasters, and there was not a single one of them who had not introduced an installation of electricity. He supposed that the Gas Company had lost some 20 million cubic feet of their total output in this way. But still they were increasing in their consumption otherwise. This year they had an increase of something like 18 or 19 million cubic feet. And so electricity had not injured them in any way. They were able to sell gas at 2s. 6d. per 1000 cubic feet. Theirs was an incorporated Company, and had to pay 10 and 8 per cent. on their capital. It took 10½d. per 1000 cubic feet to pay their dividend; while Mr. Ewing, his neighbour, slipped through with 2½d. per 1000 cubic feet. There was no doubt that electricity had come to stay with them; but they need not get afraid of it.

Mr. M'GILCHRIST pointed out that, while Mr. Wilson said that electricity had done him no harm, he said he lost a consumption of 20 million cubic feet a year through electricity having been introduced into the iron-works.

Mr. WILSON: We are gaining, on the other hand.

Mr. M'GILCHRIST: It is the loss I am referring to.

Mr. D. VASS (Edinburgh) said Mr. Yuill gave the quantity of gas made in 1887, and the quantity made in 1897; and he assumed a figure. He thought that if they were to get the net figure it would improve the matter, because the revenue would not be the same in both years, else they would be making no

progress in the way of reducing the price of gas. He thought it would be matter of interest to them if Mr. Yuill could give them the correct figure, instead of an assumed one.

The PRESIDENT said there were one or two things in the paper which he considered highly important. There was the question of gas-fittings in houses. In Dunfermline, he had had great trouble in getting gas-fitters and architects to put in fittings of sufficient size. In one case of a house with, perhaps, 80 lights, there were several large sections lighted with No. 8 internal compo. piping, which was altogether inadequate; and, of course, it was impossible to prevent complaints arising. Mr. Yuill also mentioned the small openings at the bottom of globes. There was one plumber in their town, who, certainly, in other matters, kept himself ahead of all others, but who had actually, to-day, no other globes for sale in his shop except those with the smallest of openings.

Mr. YUILL, in reply, said as to Mr. M'Gilchrist's remarks, he had only given the facts in his paper as he had been able to find them; but he had no antagonistic feeling towards the electric light. To show that this was so, he might mention that they petitioned Parliament for a Provisional Order (and got it the previous month) for lighting Alloa by electricity. They intended to establish the installation at the gas-works, to be worked by gas-engines; and so it was probable that within two years they might be in a position to supply not only gas, but electricity for both light and power. Perhaps this might tend to satisfy Mr. M'Gilchrist. Mr. Wilson mentioned the difficulties he had experienced in dealing with the electric light, and the bad position in which the Electric Lighting Company in Coatbridge was even to-day. He thought that any of them who knew Mr. Wilson would expect that, with his winning ways and persuasive powers, he would come off victorious in dealing with consumers, and have the whole place lit with gas. Mr. Vass raised a point about his giving the revenue from gas ten years ago. It was a simple calculation. If they took the average price of gas now at 2s. 6d. he thought that most of them must admit that if they took the price of gas ten years ago, it must be a little more. So that he had only taken the difference in the selling price; and anyone could make the calculation for himself. He thought it would be misleading to take the price of gas ten years ago. Then, perhaps, they would notice that, at the end of his paper, the total quantity of gas made for the past year was given—so far as it could be ascertained; and anyone could thus calculate for himself what the monetary value would be. No one, except

the President, had touched upon the subject of gas-fittings in houses. In his (Mr. Yuill's) opinion, it was the crucial point. He thought they should take it up. He considered it a question of far more importance than meter-unions. It affected not only the health of the people who lived in the houses, but the prosperity of the very gas undertaking itself.

ELECTION OF OFFICE-BEARERS.

The SCRUTINEERS (Mr. J. Hepworth, of Edinburgh, and Mr. Lamb, of Manchester) reported the result of the ballot for the election of office-bearers as follows:—

President.—Mr. W. Ewing, Hamilton.

Vice-Presidents.—Mr. W. R. Herring, Edinburgh; Mr. J. Henderson, Newton-on-Ayr.

Secretary and Treasurer.—Mr. R. S. Carlow, Arbroath.

Members of Committee.—Mr. T. Lighbody, Renfrew; Mr. Forbes Waddell, Forfar; and Mr. A. MacPherson, Kirkcaldy.

Auditor.—Mr. R. B. Main.

Mr. M'GILCHRIST said it had been reported to him that there was a way of getting votes by circular. He should like the President to say whether this was a legal proceeding. Was it not the rule of the Association that the ballot-paper was the only way of ascertaining the minds of the members as to the governing body of the Association?

The PRESIDENT: Yes; that is the way. If we had any proof of systematic getting of votes otherwise, they should be ruled as incompetent.

PLACE OF NEXT MEETING.

It was resolved that the Association meet in Edinburgh next year.

Professor W. IVISON MACADAM (Edinburgh) then delivered a lecture on "Carburetted Water Gas," of which the following is a summary. The lecture was illustrated by diagrams and views, shown by means of the limelight.

CARBURETTED WATER GAS.

The subject I am to lay before you cannot now be said to be a new one; for within the last few years the process of the manufacture of carburetted water gas has been adopted in many—I might almost say most—of our large cities and towns. Not only is the process a rapid and comparatively easy one to work, but the enormously less space required for the plant, the

ease by which the quality and even quantity may be varied at the pleasure of the operator, as well as the almost complete absence of dirt and dust, are points which no gas manufacturer can afford to neglect. Still, however, many gas managers have not yet had an opportunity of studying the subject and seeing the plant; and it has, therefore, seemed desirable that the subject should be brought before you this day.

The reactions necessary for the production of this gas are neither difficult to understand nor novel; and they may be represented thus—

(*a*) Carbon and air = carbonic anhydride and nitrogen.
(*b*) Carbonic anhydride and carbon = carbonic oxide.
(*c*) Carbonic oxide and air = carbonic anhydride and nitrogen.
(*d*) Carbon and steam = carbonic anhydride and hydrogen.
(*e*) Carbonic anhydride and carbon = carbonic oxide.

The plants now most commonly in use are known as the Humphreys and Glasgow and the Economical Gas Apparatus Construction Company (Merrifield-Westcott-Pearson patents).

The Merrifield-Westcott-Pearson plant consists of two special pieces of apparatus—one, the generator, and the other a combined carburetter and superheater. The remainder consists of washer, condenser, purifiers, &c.; and these do not differ materially from similar apparatus in use in coal-gas works. In the plant now under consideration, the combined carburetter and superheater is really two pieces of apparatus—the lower part being the carburetter, and the upper part the superheater. The Humphreys and Glasgow apparatus is constructed in three parts: (*a*) a generator, (*b*) a carburetter, and (*c*) a superheater —so that the essential difference in these two styles of apparatus lies in the combined carburetter and superheater of the Merrifield-Westcott-Pearson plant, as against the separate carburetter and superheater of Humphreys and Glasgow.

In considering the separate parts of the apparatus, I will specially explain the Humphreys and Glasgow style, as being more readily understood. The generator is simply an iron casing lined with fire-brick, and closed top and bottom. The fire-bars are raised some distance from the lower end, and can be reached by means of air-tight doors. The coke or other carbonaceous fuel is introduced at the top by means of a door. The fuel is dropped in from a specially-constructed hopper truck, which can be readily run over the upper opening. In this way, charging does not take more than a few seconds; and the fuel does not require to be handled. By means of pipes,

air or steam may be driven into the generator as required. The carburetter is also an iron cylinder lined with fire-brick, and filled in with bricks so as to make a checker-work, and thus expose great surface. Instead of fire-bricks, the upper part is filled with iron bars. It is in this apparatus that the oil required to give luminosity to the water gas is introduced, and it is found in practice that if the oil is allowed to fall on hot bricks, these are somewhat readily destroyed. Iron bars, therefore, replace bricks in the upper part. The carburetter is also furnished with an air-blast. The superheater is rather larger than the carburetter, but is otherwise very similar. As, however, it is in one of the operations the end of the system, it is furnished at the upper part with a door, by which the products of combustion may be allowed to escape. It is, like the carburetter, filled with brick checker-work. An air-blast can also be turned on to the superheater.

Suppose now that the apparatus is ready to heat up. A coke fire is lighted in the generator, and by means of an air-blast is compelled to burn in the closed vessel. The carbon of the coke, along with the oxygen of the air, forms carbonic anhydride (carbonic acid). The combustion so set up heats the upper layers of coke, with the result that the carbonic anhydride attacks the coke and becomes carbonic oxide—

$$C + \text{air} = CO_2 + N$$
$$CO_2 + C = 2\,CO.$$

One essential difference between carbonic anhydride and carbonic oxide is that, while the first gas cannot burn, the second is readily combustible. It will thus be seen that the heating up of the generator is due to ordinary combustion of carbon and oxygen, and that the final product is a combustible gas (carbonic oxide). The composition of the gases escaping from the generators at this stage is—

Composition of Generator Blast Gas.

Carbonic anhydride	9·7
Carbonic oxide	17·8
Nitrogen	72·5
	100·0

From the generator, the escaping gases are passed to the carburetter, where they meet with a further air-blast, so nicely balanced as to burn only a portion of the carbonic oxide, with the result that, while a part of the carbonic oxide is burnt to

heat the carburetter, a part also escapes combustion. The action in the carburetter may be said to be as follows:—

$$CO_2 + 2\,CO + \text{air} = 2\,CO_2 + CO + N.$$

The gases from the carburetter then pass to the superheater, where once more air is forced in. In this operation the remaining gaseous carbonic oxide is burned up; and the products of the combustion are allowed to pass to the outside air. The air-blast used is under a pressure of 12 to 15 inches of water, and is obtained by centrifugal fans worked by steam, at a rate equal to 2000 revolutions per minute. The composition of the heating-up gases, as they leave the superheater, is shown in the following table:—

Composition of Blast Products as Escaping from the Superheater.

Carbonic anhydride	17·4
Oxygen	3·2
Nitrogen	79·4
	100·0

It will be observed that all the carbonic oxide has, during these processes, been converted into carbonic anhydride, and that therefore no combustible gas leaves the superheater. The whole apparatus (generator, carburetter, and superheater) has, therefore, been heated by the coke in the generator.

When the temperature has been sufficiently raised—1000° to 1200° C. (1000° C. = 1832° Fahr.)—the air supply is entirely cut off, and the door at the top of the superheater shut. The valves between the superheater and the washer and condenser are opened, and steam, at a pressure of 130 to 140 lbs. per square inch, is introduced into the generator, with the result that the hot carbon decomposes the steam, forming a mixture of carbonic anhydride and hydrogen—

$$\underset{\text{Steam.}}{2\,H_2O} + C = CO_2 + 2\,H_2.$$

And, secondly, the carbonic anhydride, meeting with the hot carbon, acts as before—

$$CO_2 + C = 2\,CO.$$

At this stage, therefore, the gases escaping from the generator are the combustible carbonic oxide and hydrogen, with a proportion of carbonic anhydride. The composition of the gas is as follows:—

Uncarburetted Gas, "Water Gas."

Carbonic anhydride	3·5
Carbonic oxide	43·4
Hydrogen	51·8
Nitrogen	1·3
	100·0

The coke from 1000 cubic feet of ordinary coal gas will yield 3000 cubic feet of water gas.

Now, while the temperature of the flame of burning hydrogen is 3259° C., and that of carbonic oxide is 3042° C., yet the flames are practically non-luminous. The generator gas is, therefore, passed to the carburetter, where it meets with a very fine spray of paraffin oil, which is vaporized by the heat of the generator gases, and carried forward to the superheater, where it is broken up, or more possibly "cracked" and converted into permanent gas of high luminosity. Russian Solar Distillate, sp. gr. 875, and flashing at 170° to 200° Fahr., gives for each 5·46 lbs. of oil 1000 cubic feet of 25-candle power gas, and the fuel required per 1000 cubic feet of 25-candle power gas is 45 lbs. The operations in the carburetter and superheater may be explained thus—

Carburetter.

Non-luminous gas + oil vapour = mixture of non-luminous gas + oil vapour.

Superheater.

Mixture of non-luminous gas + oil vapour = mixture of luminous and non-luminous gas.

The composition of the gas is as follows:—

Composition of Unpurified Carburetted Gas.

Carbonic anhydride Sulphuretted hydrogen	3·8
Heavy hydrocarbons	14·6
Carbonic oxide	28·0
Marsh gas	17·0
Hydrogen	35·6
Nitrogen	1·0
	100·0

Any condensable hydrocarbon is removed by the washer; and the sulphuretted hydrogen and carbonic anhydride are taken out by lime or lime and oxide of iron in ordinary gas-works purifiers. There is nothing novel in the method of purifying the gas, as only the ordinary systems, so well known,

are employed. There is only a slight proportion of sulphuretted hydrogen; and it comes to be a matter of consideration whether it is cheaper to remove the carbonic anhydride, or to simply increase the proportion of oil used, and so overcome the loss of luminosity due to the presence of that gas.

It can be readily understood that, with such operations, it is essential to save as much heat as possible; and with this end in view, the oil is heated before it is allowed to pass to the carburetter. Humphreys and Glasgow use the waste heat of the superheater; while the Economical Gas Apparatus Company prefer to use the waste heat of the cooling apparatus. It will be readily understood that the manufacture of the gas from coke, steam, and oil rapidly reduces the temperature of the whole apparatus; and therefore it is necessary, after a period of from five to seven minutes, to cut off the oil supply, shut the valves between the superheater and the purifying plant, open the upper door of the superheater, and repeat the heating-up process by means of the air-blasts as before. This operation means a loss of about four minutes, after which the manufacture of luminous gas may be repeated. This cooling is shown very well by the increase in the proportion of carbonic anhydride in the gases as passing off from the generator. After four minutes, the proportion is nearly 5 per cent.; and after seven minutes it is fully 12 per cent. The actual figures are as follows:—

Composition of Generator Gases.

	1 Min.	4 Min.	7 Min.
Carbonic anhydride	0·8	4·7	12·1
Oxygen	0·0	0·0	0·0
Carbonic oxide	48·2	40·6	29·9
Hydrogen	48·6	52·7	56·1
Nitrogen	2·4	2·0	1·9

The analyses of the average make of the unpurified and purified carburetted gases at the Liverpool works are as follows:—

Unpurified Carburetted Gas.

Carbonic anhydride	4·1
Heavy hydrocarbons	11·8
Oxygen	0·0
Carbonic oxide	30·1
Methane	20·7
Hydrogen	28·7
Nitrogen	4 6
	100·0

Purified Carburetted Gas.

Carbonic anhydride	0·0	0·2
Heavy hydrocarbons	12·3	11·7
Oxygen	0·0	0·1
Carbonic oxide	32·0	32·1
Methane	21·2	21·2
Hydrogen	28·2	28·8
Nitrogen	6·3	5·9
	100·0	100·0

For those who may desire more detailed information as to the actual constituents present in the gas, the following analysis of a sample of the Baltimore Gas-Works product may be found useful:—

Hydrogen		46·49
Marsh gas		11·75
Carbonic oxide		21·51
Nitrogen		4·30
Oxygen		0·20
Olefine Series.	Ethylene	6·50
	Propylene	0·35
	Butylene	0·15
Paraffin Series.	Ethane	0·50
	Propane	1·00
	Butane	7·25
		100·00

The following table of the composition of ordinary cannel coal gas is given for comparison:—

Composition of Cannel Coal Gas.

Hydrogen	45·58
Marsh gas	34·90
Carbonic oxide	6·64
Heavy hydrocarbons	6·46
Nitrogen	2·46
Carbonic anhydride	3·67

On comparing this table with the previous results, it will be observed that the constituents present are the same, and that the main difference lies in the larger proportion of carbonic oxide, and the lower amount of marsh gas in the carburetted gas, as compared with the coal gas. If we consider the illuminating value of the constituents, we shall find that the substitution of carbonic oxide for marsh gas will not to any extent affect the luminosity, as, while these gases are practically non-

luminous, marsh gas is in practice found to be more harmful to luminosity than carbonic oxide.

Lighting Value of 5 *Cubic Feet.*

	Candles.
Carbonic oxide	—
Marsh gas	5·2
Ethane	35·7
Propane	56·7
Olefine	70·0
Propene	123·0
Acetylene	240·0

The interchange of gases will, however, to some extent affect the thermal value of a definite weight of the gas, for a given weight of marsh gas is of more value for heating purposes than the same weight of carbonic oxide.

So far I have been making use of tables published by the patentees; but I now quote independent evidence. This can readily be given; for the Edinburgh and Leith Gas Commissioners have lately gone most fully into the matter, and have had the best scientific assistance procurable. The results I now show fully corroborate the figures previously quoted, and distinctly prove that the claims of the patentees have not been exaggerated.

Unpurified Carburetted Gas.

Edinburgh Tests (Professor Crum Brown).

Carbonic anhydride	4·2
Heavy hydrocarbons	10·5
Oxygen	0·0
Carbonic oxide	32·8
Methane	16·5
Hydrogen	32·2
Nitrogen	2·8

Purified Carburetted Gas.

Edinburgh Tests (Professor Crum Brown).

	A.	B.	C.	D.
Carbonic anhydride	0·2	0·2	0·3	0·2
Heavy hydrocarbons	12·6	13·6	11·9	11·0
Oxygen	0·0	0·0	0·0	0·0
Carbonic oxide	28·6	26·6	29·9	30·5
Methane	15·9	19·9	18·0	17·5
Hydrogen	35·4	33·5	34·9	35·7
Nitrogen	7·3	6·2	5·9	5·1

Purified Carburetted Gas.

Edinburgh Tests (Mr. Stenhouse).

	No. 3.		No. 4.
Sulphuretted hydrogen	0·0	..	0·0
Carbonic anhydride	0·0	..	0·0
Hydrocarbon vapours	1·5	..	0·9
Heavy hydrocarbons	7·6	..	7·8
Oxygen	0·4	..	0·0
Carbonic oxide	30·0	..	30·7
Marsh gas	29·3	..	32·8
Hydrogen	19·9	..	18·0
Nitrogen	11 3	..	9·8
	100·0	..	100·0

Candle power, 20·22.

The last table may be compared with Mr. Stenhouse's analyses of the cannel gas as now supplied to the City of Edinburgh.

	First Analysis.		Second Analysis.
Sulphuretted hydrogen	0·0	..	0·0
Carbonic acid	0·0	..	0·6
Hydrocarbon vapours	1·2	..	1·2
Heavy hydrocarbons	7·2	..	7·6
Oxygen	0·2	..	0·2
Carbonic oxide	9·6	..	9·8
Marsh gas	38·4	..	38·4
Hydrogen	43·3	..	42·2
Nitrogen	0·1	..	0·0
	100·0	..	100·0

The question of cost is one which I am not qualified to deal with; but I may annex a table, the details of which have been compiled from the books of one of the most energetic and accomplished of gas makers—Mr. Stelfox, of the Belfast Corporation Gas-Works.

Cost of Manufacture of 25-Candle Power Carburetted Water Gas.

	Pence.
Oil, 3⅝ gallons, at 2¾d.	10·10
Coke (including boiler fuel)—45 lbs., at 12s. per ton	2·90
Labour, total employed	1·50
Purifying materials	0·50
Repairs and maintenance	1·00
Water (if not re-circulated)	0·20
Management and sundries	0·80
Total cost per 1000 cubic feet made	17·00
Plus 5 per cent. lost in distribution	0·85
Total cost per 1000 cubic feet sold	17·85
Cost per pound of sperm sold	0·208

This estimate does not include the value of residual tar, which is equal to 10 to 15 per cent. of oil used, and fetches in one works 19s. per ton, as against 21s. per ton for coal tar. From the character of the materials used, as well as of the plant, it can easily be understood that there is little or no dust and no smoke. All the disadvantages of the old retort-house are done away with. Of course, as coke is required, it is cheaper and better to continue the old process side by side with the new; but any manager can so regulate the excess production of coke that no more is made than can readily be sold, or he can even regulate matters so that no coke is sold. The coal gas can be easily mixed with the carburetted gas; and if once mixed the gases cannot separate, for gases are quite different from solids, or even liquids, as one of their essential physical properties is that they must mix, no matter what their densities be, and that once mixed they cannot again become layered.

The specific gravity of ordinary coal gas is about 470; of water gas, 570; of the Belfast mixed coal and carburetted water gas, 545. The enriching value of carburetted water gas is about one-fifth, or 20 per cent., more than its nominal value.

Another great advantage is the comparatively small space occupied by these plants. Four complete sets can be placed in a building 95 feet by 55 feet; and this includes plenty of room, not only for the generators, carburetters, and superheaters, but also for the necessary boilers, air-fans, engines, a store-room, and office. But it does not include purifying plant or holders. Such a plant can easily manufacture 1,400,000 cubic feet of illuminating gas per day.

The great outcry against the carburetted water gas is that the largely increased proportion of carbonic oxide makes the gas very poisonous. Now, there can be no doubt that carbonic oxide is an extremely poisonous gas—in fact, so poisonous that even a small proportion in admixture is highly dangerous. In the Edinburgh coal gas there was nearly 10 per cent. of carbonic oxide. Now, such a proportion is most highly poisonous; and the mere increase in the proportion cannot make the mixture any more fatal. On the other hand, it has been suggested that carbonic oxide being odourless, it becomes more highly dangerous when in carburetted gas than when in coal gas. But those who urge this theory altogether forget that while their contention would be perfectly correct were pure water gas sent out to the consumer, it is absolutely unfounded when carburetted water gas is delivered to the mains. Those who have had experience of oil gas well know that such gas has a much stronger odour

than ordinary coal gas; and therefore the mixture of oil gas and water gas, known as carburetted water gas, should it escape into a room, will be more easily and more early detected than coal gas would be. If the gas manager is to be compelled to turn out non-poisonous gas, he must shut up his works.

Discussion.

The PRESIDENT said he was sure the members were all very much indebted to Professor Macadam for his valuable contribution to the day's proceedings. If anyone had any questions to ask, he had no doubt Professor Macadam would give them satisfactory answers.

Mr. J. NAPIER MYERS (Saltcoats) said he understood Professor Macadam to say that while solids, and even liquids, might be mixed and separated, the same did not hold good of gas, but that when gases were once mixed there was no possible chance of separating them. He should like to know if the opinion held by some gas managers, that gases of different qualities were apt to form layers in a gasholder, was a fallacy. He could not say he had experienced it himself; but he had frequently heard gas managers say this would result.

Mr. T. WILSON (Coatbridge) said Professor Macadam had furnished them with particulars of the different water-gas apparatus, and the working of them, and also the cost of working at Belfast. He thought he had omitted to give them the illuminating power in that city.

Professor MACADAM said it was 25 candles.

Mr. WILSON said this would enable them to determine whether coal gas or water gas was the more suitable.

Mr. A. BELL (Dalkeith) said he had never had anything at all to do with the manufacture of carburetted water gas for illuminating purposes; but some years ago he was concerned with the manufacture of a gas containing from 15 to 20 per cent. of carbonic oxide. With regard to its poisonous properties, he was not so very sure that Professor Macadam had put the matter his way. The question he wished to ask was whether it was not cumulative—did not the human system hold water gas for a much longer time than ordinary coal gas? If they doubled the quantity of carburetted water gas, surely it must be more poisonous than the smaller quantity of carbonic oxide in coal gas. Suppose two men were asphyxiated, the one with coal gas and the other with carburetted water gas, which would be the more likely to recover? He held that the coal-gas man would, and that the other would go. In an oil-works, the place of which he was

speaking—of course, it was a rough place, and no cutting off, requiring the apparatus to be shut down—if anything went wrong they had to cut in and let the gas blow freely. Some men could stand it well, but others very little. He himself could stand a great deal of coal gas without being asphyxiated. He had a man in his employment who, if he got three breaths of the gas they manufactured, went into convulsions. He was a fitter, and a good workman; but, being of no use to them, he had to leave. He went to Glasgow, where he could stand the old quantity of coal gas. This showed that there was a difference between the two gases. He had been twice asphyxiated himself. He had all his life made it a point that wherever there was danger he gook it himself, because he knew exactly the moment when to stop. With water gas, however, a man stood no chance; he simply went down like a stone. He had twice been carried out insensible. One poor fellow, after perhaps a dozen such cases, was incapacitated for life—the man became useless. He held that the gas was deadly poisonous, and that it was doubly dangerous to have twice the quantity of carbonic oxide in it. If they were using water gas, they surely must increase the danger. Many people had no smell. He had a man in his works who could allow gas to blow all round him, and not know of it. A man like this would be simply killed if he breathed water gas. He would like to ask Professor Macadam if the poison in this gas was not cumulative.

Mr. A. WILSON (Dawsholm) said that, as one who had had a little experience in the manufacture of water gas, he considered there was not much more danger with it than with coal gas; nor did he think that there was any more risk in the use of it. Mr. Bell talked about men getting asphyxiated. He did not think that in his works men were ever in positions where they could be asphyxiated. He did not consider that a man should be placed in a position where he would get such a dose of gas—either coal gas or water gas—as would do him harm. But he really did not think it would make much difference whether it was coal gas or water gas. He thought the evidence was that the latter could be used just as safely as the former, and that accidents with it were not more frequent than with coal gas. The point, of course, which everyone must consider for himself was which was the more economical to make, water gas or coal gas. In some cases—certainly in his own experience—it was much cheaper to make coal gas and enrich with oil gas than to make carburetted water gas. There were thus circumstances where it might be more economical to use water gas; but in other

cases he thought that coal gas, if it were economically made, would for a long time certainly hold its own with water gas.

Professor MACADAM said the first question put to him was by Mr. Myers—as to gases layering. In answering this question, he thought he must, in the first place, draw attention to the fact that he said that "gases when once mixed cannot layer"—that was to say, that if they mixed gases thoroughly, as should be done, they could not be again separated from one another. They could not have heavy carbonic acid separated from light hydrogen when once they were mixed together. This was a well-known physical condition. If they were to send into the gasholder probably a heavier gas at one time than at another, they might have, for a time, what was known as layering—there was no question about that. After a while, if they had time, they would pass through one another—diffuse through one another—and then the mixture became homogeneous. But there was no doubt that, if they put into a holder a heavy gas and then a light one, they would have layering, but only for a time. He maintained that gases once mixed could not separate. Then as to the quality of the gas. In Belfast it was 25 candles; but they might turn out an 18-candle, a 30-candle, or even a higher quality gas. It was simply a matter of the quantity of oil they put in. That was one of the advantages of the process. In Mr. Bell he had a more serious antagonist to attack. But, in the first place, he thought that gentleman was wrong about asphyxiation. He believed it required a very strong man indeed to stand oil gas. He (Professor Macadam) was in the same position as that referred to by Mr. Bell. Coal gas did not affect all to the same extent; but the gas from paraffin was a totally different matter, because it contained an amount of sulphuretted hydrogen. In this they had an altogether new element introduced, and a very poisonous gas. Therefore he was not at all astonished at Mr. Bell's statement. In fact, he had himself seen men affected by paraffin oil gas. Coal gas did not affect himself; but he did not think this had anything to do with the poisonous property of carburetted water gas. If a man took 2 per cent. of prussic acid, it was poisonous; if he took 100 per cent., it was more poisonous. But he did not think it mattered to the man whether he was killed by 2 per cent. or 100 per cent., as they were both certain to kill him. To breathe 5 per cent. of carbonic oxide was poisonous within five minutes, let them mix any way they liked. Carbonic oxide was the most poisonous gas they had at present, and if they took an ordinary coal gas, with a mixture of 10 per cent.

of carbonic oxide in it, it was much over the poisonous quality. By most people, a very much less percentage of carburetted water gas than of coal gas was noticeable by the odour of it. He did not, however, take exceptional noses such as Mr. Bell had just mentioned. Therefore he considered that carburetted water gas could not be held to be more dangerous than coal gas. Mr. Wilson had used the words "water gas." But he must again draw their attention to the difference between the two gases—water gas and carburetted water gas.

Mr. WILSON: I intended to speak of carburetted water gas.

Professor MACADAM: Then I have simply again to try to force upon the meeting the absolute necessity there is nowadays, with two distinct processes, of using the terms correctly.

The PRESIDENT asked for a hearty vote of thanks to Professor Macadam; and this was accorded.

KEITH'S AUTOMATIC AIR AND GAS COMPRESSORS.

Mr. GEORGE KEITH, jun. (London), read the following paper, prepared by his father, Mr. James Keith, illustrative of Keith's automatic air and gas compressors, an exhibition of which was given on the platform:—

Ever since the introduction of high-pressure incandescent gas-lighting in Belgium by the Somzée-Greyson Company, many attempts have been made to produce an apparatus for compressing ordinary coal gas taken from the street-main, and supplying the gas so compressed regularly and steadily to the burners and mantles in use. Naturally, water pressure, or water power, has generally been applied for the working of the gas compressors produced. But the cost of water under pressure being considerable in most towns and cities in the United Kingdom and elsewhere, the game, after all, was scarcely worth the candle, unless such machines could be made to work efficiently and economically either with a low water pressure or with a water cistern on a second floor, and above all automatically; and this is what has never been done until Keith's Automatic Air and Gas Compressors came upon the scene.

This invention is worked by the ordinary water service, either from the main or a cistern; is absolutely automatic in action; acts as a governor as well as a compressor; uses an infinitesimal amount of water (only from about one to one-and-a-half gallons per hour for every 10 cubic feet of air or gas compressed); meets with the approval of the water companies; is silent in operation, and has practically no visible movement; is devoid of friction in

the air and gas-pump portions, which require no leathers nor packings nor oiling; can be placed almost anywhere with safety; gives a steady unvarying pressure of air or gas without pulsation on either the inlet or the outlet side; and is acknowledged to be the most compact, economical, and perfect apparatus of the kind.

For high-pressure incandescent gas lighting, or for the compression of air and the supplying of it under pressure for the better combustion of acetylene gas, Keith's apparatus mentioned stands unrivalled; and the cost of water for working need not be taken into account, as, even at the high price of water in London, the cost only amounts to about 1d. for every 1000 cubic feet of gas or air compressed and used, while the apparatus being entirely automatic, the whole action starts or stops on the mere turning on or off of the gas or air taps at the burners. The apparatus is at present made in two sizes, which are of different construction; but in both the principle is essentially the same. They consist of a reciprocating water-motor, acting directly on a practically frictionless, double-acting pump, which takes the gas from the main, and then forces it into a small holder weighted to the desired pressure, which, in the case of the Somzée-Greyson burners, is from 7½ to 8 inches water-gauge. This holder is arranged so as to control the water supply to the motor—shutting it off when rising, and opening it when falling. In the case of the small machine [one of which was shown upon the platform], which is arranged for supplying from 100 to 150 cubic feet of compressed gas per hour), the pump and motor parts are enclosed by the weighted holder; while in the larger apparatus, which will supply from 300 to 500 cubic feet per hour, the holder floats in a tank alongside the pump and motor portion, but on the same base. In all other machines for the same purpose, the principal trouble has been experienced with the pump portion; the work done in overcoming the friction of the pistons and glands of which amounted to considerably more than the actual work performed in raising the pressure of the gas, even when kept well lubricated and fairly slack, to say nothing of the trouble arising after being in use for a time, owing to leakage of gas at the glands and pistons, and the clogging up with dirty oil. All these troubles are overcome in the Keith apparatus, by using, instead of a fitted and packed piston, a small holder or bell, working in a deep annular water seal. This gives at once an absolutely tight piston, with no friction, and requiring no lubrication or cleaning whatever. The top and underneath portions

of the pumping-bell are each connected to suitable inlet and discharge valves, so arranged as to make it double acting. In the case of the water-driven compressors, the discharge of the motor is arranged to pass through the seals and keep them overflowing; and from thence into the holder seal, before being run to waste. It will at once be seen that, by doing away with the friction of the piston and glands of the pump, the power required for raising the gas pressure is reduced to the minimum.

As is now well known, gas burned under the high-pressure incandescent system at from 8 to 10 inches water-gauge pressure, gives about 30-candle power for every cubic foot of gas consumed; so that the smaller size apparatus exhibited is capable of furnishing about 4500 illuminating candle-power, while the larger apparatus is capable of furnishing about 15,000 illuminating candle-power, at a cost for gas of 150 and 500 cubic feet per hour respectively, and at the merest trifling cost for working by water. Unlike other arrangements for a similar purpose, the apparatus described is entirely free from smell, noise, and irregularity in working. These figures apply to the use of 16-candle power London gas; and, without doubt, the results would be even better with Scotch gas.

Keith's apparatus is being used preferentially by the Intensified Gaslight Company, Limited (Somzée-Greyson System), by the Welsbach Incandescent Gas Light Company, Limited, and by others, for their high-pressure systems of gas lighting. The plant is in use for lighting the large lamps in front of the London Pavilion, Piccadilly, the Metropolitan Music Hall, Edgware Road, and elsewhere in London and the Provinces.

The foregoing description applies to the gas-compressors worked by water pressure. Very often, however, water pressure is not available, or it is, perhaps, inconvenient or expensive to apply water power to such mechanism; accordingly, under recent developments, the same end can be attained without the adventitious aid of water, as is illustrated by the latest form of Keith's apparatus now shown—the power for working the apparatus being wholly obtained from the heat of a gas-burner.

The small apparatus, working in the manner here described, without the use of water pressure, but by power developed in a little hot-air motor, merely from the heat of a bunsen burner consuming a few feet of gas per hour, is capable of supplying (say) 15 Somzée-Greyson burners, each consuming 10 cubic feet of gas per hour. Each burner gives a light of 300 candles, and is the perfection of simplicity in power development from the gas itself, and in the working mechanism.

Of course, the working mechanism of the compressor may be driven by any other mechanical power—such as electricity, a running shaft, or any other power available—in a manner somewhat similar to that of driving it by the hot-air motor. The result, so far as the invariable pressure obtained (whether the full number of burners be turned on or not), and the perfect automatic action of the compressor itself, is the same as with the apparatus shown at work, or with the compressors worked by water pressure previously described.

It may be explained that while the automatic action of the water-driven and hot-air driven machines is due to the rising and falling of the loaded gasholder into which the gas is compressed, and the result—perfect automatic regulation—is the same, there is a difference in the way this is brought about. In the case of the compressor worked by water motor, the water pressure actuating the motor is externally turned off or on by the variation in level of the loaded gasholder—the dropping of the gasholder turning on the water. In the case of the compressor worked by hot-air motor, it is the gas itself which is controlled by the rising and falling of the loaded gasholder; the rising of the gasholder beyond a certain level practically stopping the inlet of the gas from the main to the compressor valves, and enabling the compressed gas inside the apparatus to be circulated by the compressing bell—any additional gas from the main being admitted automatically as it may be required.

The apparatus is also suitable for automatically increasing the pressure of gas in buildings or districts where an exceptionally low gas pressure prevails; compressing oil gas, acetylene gas, air, &c., and supplying these without variation at the increased pressure; making and supplying air gas; and (by another modification) compressing and mixing air and other gases in measured, regular, and unvarying proportions.

Keith's automatic compressors can be made of any size suitable for any requirements; and when used automatically for increasing the gas pressure on special buildings, or in low-lying districts, they can be made in duplex form, so far as the pumping or compressing parts are concerned, in order to give increased efficiency and simplicity—the two or more pumps working into one large holder. The *Journal of Gas Lighting* lately described the construction and action of Keith's automatic compressors, and their suitability for increasing pressure.*

The burners exhibited in connection with the apparatus are the Somzée-Greyson burners, which, up to the present, are

* See Vol. LXXIII., p. 1363; and Vol. LXXIV., p. 37.

undoubtedly the best burners for high-pressure incandescent gas lighting. The mantles for these burners are specially prepared by the Welsbach Company, and are extra strong ; and, although they might, with profit, last longer, these mantles sometimes last with apparent full efficiency for six months or more. Undoubtedly, the higher pressure of the compressed gas, and the air induction passing through the mantles, blow off the burnt dust or carbon, and tend to harden the framework and prolong the life of the mantles.

The conclusion that there is a bright future opening before the principle of high-power gas lighting, appears to be quite irresistible; and those gas corporations and companies who give this system of lighting most encouragement, as well as those incandescent gaslight companies who decide to make the system a speciality, will, under proper conditions, before very long reap a rich reward.

Discussion.

The PRESIDENT was sure they were all very much indebted to Mr. Keith for showing his apparatus; and, personally, he was very glad that he had brought the apparatus worked by hot air. He thought it was to be preferred to the hydraulic machine, because it put the whole system under gas, which was of very great advantage to them.

Mr. A. BELL (Dalkeith) asked at what pressure the gas was going into the burners.

Mr. KEITH: 7½ inches.

Professor MACADAM said he should be very much obliged if the reader of the paper would give them some information as to the constitution or composition of the mantles which he had shown, and which, as he had told them, would last for six months with unimpaired luminosity; because it was well known to those who had used the mantles of any Company—and more so of the Welsbach Company—that there was a very great loss of luminosity. If, therefore, the Welsbach Company had now been able to bring out a mantle which would not be affected by long use, but would rather be improved, then they had certainly solved a very great difficulty. He had had considerable experience with Welsbach burners, and he was not perfectly clear that there was very much saving in cost in using these burners, because what saving there was in gas was lost in the cost of extra mantles. He had been balancing up the accounts of his house very carefully; and, beyond the fact that there was increased luminosity (which, he admitted,

was a considerable matter), there was not much saving. He should like to know what the composition of the improved mantle was; and if it were patented, the number of the patent, so that he might be able to find out its composition.

Mr. T. DOUGLAS HALL (Montrose) said he should like to ask a very simple question. The pressure, at that moment, was 7½ inches, what was the consumption at the point of combustion? Did the increased pressure increase the consumption at the point of combustion?

Mr. A. MACPHERSON: Perhaps Mr. Keith will tell us what amount of gas is being consumed in the motor.

Mr. KEITH did not think he made the statement that the mantles shown were improved by being kept burning. The statement he did make was that the mantles did not lose their luminosity so soon as they appeared to do under ordinary conditions; because, for one thing, they never got smoked. He could not give Professor Macadam the composition of the mantles. He did not profess to know anything whatever about them; the only thing he professed to know about was the machine he used. But certainly, from his own experience, he found that, when he got a good mantle, it would last a very long time. He only had the authority of the Welsbach people themselves for saying that the high pressure had the effect of hardening the mantles. There was one thing, though, that while the mantle did last they were getting a great deal more out of it; they were getting (say) 300 candles out of one of these mantles, as against the usual 60 candles. The mantles cost, perhaps, 1s. 6d. each, as against the ordinary-sized mantles at 1s. each; and, supposing a mantle to last only a quarter of the time with high pressure, they would be getting value out of it all the while. About the consumption of the burners at low pressure, he would hardly like to speak, because it would vary very much with the pressure at the time, and he had no figures to work upon.

Mr. HALL: I do not think Mr. Keith has exactly understood my question. I want to know the consumption at the ordinary pressure, and under the 7½ inches of pressure.

Mr. KEITH said that, with London gas, the consumption at high pressure was 10 cubic feet. It might be a little more with Scotch gas; but they were getting 300 candles.

Mr. BELL: Is that without variation of pressure?

Mr. KEITH: Without variation. The real secret of it was that, by increasing the pressure of the gas, more air was drawn in at the burner; and it was found that, with 16-candle gas, five to one gave the best results. They might burn more gas by

making it four to one. It was a question, with richer gas, whether they could not reduce the nozzle; and in this way mix more air with the gas. He had experimented with mixtures above five to one—as much as eight to one; and at eight to one he got no luminosity at all. There was so much air in the gas that there was not sufficient heat to heat up the mantle at all.

Mr. M'GILCHRIST: What is the consumption of gas under the present conditions? and what would be the consumption under the increased pressure? At the present time, with a Welsbach light, there is a consumption of something like 3½ or 3¾ cubic feet. What extra gas is consumed by the increased pressure?

Mr. BELL: Has that ever been tested by meter?

Mr. KEITH said it had; but he could not then give the actual result. All he could tell them was that, of course, they could not compare the burner he had shown with the ordinary incandescent burners at all. As it was burning before them, it was not getting the full efficiency of the extra pressure. One of the greatest advantages of the apparatus shown was that, if anything should go wrong with the machine, or anything else, the gas went through at the ordinary pressure, and they got some light; they did not go into darkness. The apparatus was not meant for a low pressure; it was intended for a high pressure and nothing else. They could not get at what the consumption of gas would be with a low pressure.

VOTES OF THANKS, ETC.

The PRESIDENT said they had had very good papers from Mr. Yuill, Professor Macadam, and Mr. Keith; and he thought they all deserved a very hearty vote of thanks, which he had great pleasure in proposing.

Mr. T. WILSON (Coatbridge), the Past-President, said he had a very pleasant duty to perform in presenting to Mr. Pooley the President's Medal. He hoped it would keep Mr. Pooley in mind of as successful a meeting as the Association had ever had; and he trusted that Mr. Pooley would be long spared to wear it.

The PRESIDENT thanked Mr. Wilson, and all the members, for the medal, which he should prize very much. He should keep it as a memento of this most successful gathering.

Mr. EWING proposed a vote of thanks to Mr. Carlow for the excellent way in which he had carried on the Association during the year, and for his assistance in the conduct of the business.

Mr. CARLOW said the work of the Secretary was certainly very great at all times; but he was amply repaid when he saw the

members turning out in such large numbers. One thing he would say, that this year he had had much more difficulty in persuading members to come forward and give papers for the meeting. Had it not been for the kindness of Professor Macadam and Mr. Keith, the meeting would not have been so successful as it had been; and he would impress upon the members—more especially the younger ones—their duty of coming forward to take part in the work of the Association. Unless they did so, the work for which it was established would come to a stand-still. So far as he was concerned, he would spare himself no labour in conducting the affairs of the Association; but he had a feeling that as he had been Secretary for over twelve years, he should resign the secretaryship, and let a younger man take the reins. He would now give intimation of his intention, so that next year, in the ballot-paper, they might substitute another name for Secretary.

Mr. M'GILCHRIST believed he represented the views of the members generally when he expressed the opinion that, if Mr. Carlow thought he had not got very good masters, they knew that in him they had a very good servant; and they hoped the day was far distant when Mr. Carlow would leave his post.

Mr. YUILL said that perhaps they were not all aware of the amount of labour and trouble Mr. Smith, of Stirling, had had in arranging for the meeting; and he thought they ought not to leave without according to that gentleman a hearty vote of thanks for the trouble he had been at in trying to accommodate them.

Mr. SMITH, in a word, returned thanks.

This concluded the meeting.

The members and friends dined together in the Station Hotel —Mr. POOLEY presiding. A short toast-list followed.

On Friday a most delightful excursion, attended by over 150 persons, took place from Stirling to the charming district of the Trossachs. Among the guests present were the respected father of the President. After a visit to the lower end of Loch Katrine, luncheon was served in really first-class style in the Trossachs Hotel. On the return journey, tea was partaken of in the Dreadnought Hotel, Callander; and on the platform of the railway station there the assemblage dispersed.

NORTH OF IRELAND ASSOCIATION

ANNUAL MEETING, AUG. 8.

This Meeting was held in the City Hall, Dublin—Mr. J. AUCHTERLONIE, of Mullingar, the President for the year, in the chair. There was a very good attendance.

REPORT AND ACCOUNTS.

The report of the Committee, with the accounts, was submitted. The Committee expressed regret that during the year death had claimed one of their number—Mr. Patrick Egan, of Tralee. Knowing that he had left a large family who were not well provided for, £5 was voted from the funds of the Association, which the Committee supplemented by individual subscriptions; so that a sum of £12 7s. was sent to the widow and family. The abstract of accounts showed a balance in hand of £24 18s. 11d. The membership of the Association stood as follows: Ordinary members, 56; extra-ordinary members, 26; honorary members, 2 —total, 84.

On the motion of Mr. D. WILLIAMSON (Clones), seconded by Mr. F. EUSTACE (Tullamore), the report and accounts were unanimously adopted.

NEW MEMBERS.

The following gentlemen were, on the motion of Mr. S. B. LANGLANDS (Coleraine), seconded by Mr. J. G. TOOMS, of Carrick-on-Suir, admitted to the Association: Barrett, P., Rathkeale; Carter, J. M., Castlebar; Dunn, J., Auchnacloy; Egan, M., Tralee; Fagan, G., Clara; Kneeshaw, W., Clonmel; Maloney, T., Cashel; Patterson, J., Tipperary; Richmond, J., Kilkenny; Skinner, Robert J., Londonderry; Stewart, G. H., Ennis; Stott, C. W., Parsonstown.

THE PRESIDENT'S ADDRESS.

The PRESIDENT then delivered the following

INAUGURAL ADDRESS.

Someone has said that there is nothing in the world so delightful as the bliss of requited love. But the conditions of human life are such that even this brings responsibilities

in its train. So, for the first eleven months of his office, the President of your Association has a very pleasant time to enjoy the privileges and honours of his position. But time passes, and he has soon to account for the faith that has been placed in him; and, to quote a phrase of one of our prominent empire makers, he has to "face the music"—the music in this case being the delivery of an address to a body of gentlemen, most of whom have far greater experience and ability than myself. In fact, so conscious am I of my shortcomings at this moment, that I am like a nervous gentleman of my acquaintance who so dreaded the ordeal of appearing before the hymeneal altar, that he was constantly debating whether or no he should pack up and make off before it was too late. Soldiers, however, tell us that it takes a brave man to run away from his comrades, and that it is fear that often impels them forward. Knowing how little of importance I can communicate to such a Society as ours, and our meeting coming so late in the season, when so many able Presidents of other Associations have already touched in a masterly fashion on all the current subjects of interest to the profession, it is only fear of ridicule, and the assurance of your kindly and sympathetic support, that has prevented my proving an absentee.

Casting about in my mind as to the why and the wherefore of Inaugural Addresses, I have come to the conclusion that it is a very reasonable practice for the Presidents to touch on the success, or otherwise, of the Societies they preside over, and to give a brief *résumé* of the progress made by the profession as a whole. In our desire for change and advancement, however, addresses have been so elaborated that they have become rather an infliction both to hearers and deliverers, unless the President has happened to be one of the pioneers in experiment and discovery. Keeping this in view, I shall confine my few remarks to what concerns the management of small gas-works, more particularly in Ireland. But before proceeding to my subject proper, I must thank you all very heartily and sincerely for the honour you have done me in electing me to the presidential chair. If I do not rise to the level of your hopes, I trust I may leave my office with its prestige undiminished.

Gas managers in Ireland suffer under many disadvantages compared with their brethren on the other side of the Channel. In the first place, we are far removed from the coalfields; and although we are again and again assured that there is an abundance of coal in Ireland, we have still to go on paying from two to three times the price paid by our more fortunate *confrères* on the

other side. The same may be said of fire-clay goods, and, in fact, of all our manufacturing plant. Again, we have to face poor prices for tar and liquor; the latter product being in many cases a source of expense instead of revenue. Our constituencies are small; and the extent of our mains, with correspondingly high leakage, is excessive compared to the output of gas and number of consumers. Nor is this latter state of affairs likely to be improved in the future; for under the Labourers' Cottages Acts our suburbs are being taken up with this class of houses, with their half-acre or more of land, and mains have to be run to light the roadways, and as there is no prospect of any return further than the few street-lamps, I fear that our unaccounted-for gas will still remain high. These causes handicap us severely, and put us entirely out of court in the struggle for statistical supremacy in the economical manufacture of gas.

There are other causes, however, which I consider detrimental to the efficiency of our works, and which, in my opinion, could be improved upon; and I would briefly direct your attention to a few of them. It is an undoubted fact that many of the smaller works in Ireland—and elsewhere, for the matter of that—are antiquated and too small for the requirements. When the manager is thoroughly competent and energetic, he works up the concern to a point that requires additional plant. But through want of enterprise or dread of competition, the outlay is refused by the commissioners or directors, with the result that progress is crippled, the cost of production remains high, and the owners leave themselves in a very weak position in the event of competition. If companies and corporations have faith and confidence in their managers, they ought to give them every assistance in the way of providing capital for the carrying out of extensions and improvements.

In these days when managers all over the kingdom throw open their works to the profession for inspection, and when they are always willing to place the results of their workings before the different associations, there need be no fear of risky experiments. Where an enlightened policy has prevailed, gas lighting is practically unassailable by any of its rivals. The proof of this is to be witnessed in several of our corporation gas-works, transferred at exorbitant valuations, more or less dilapidated when bought, and remodelled at great cost, with the result that, in spite of the heavy capital charges, the economy in working has warranted considerable reductions in the price of gas.

The maxim that the dividend is made in the retort-house is now widely recognized; and this is very evident from the great

improvement that has taken place in this part of our works within recent years. After the consensus of opinion in favour of regenerative firing in one form or another, the surprise is not at the wide adoption of improved settings, but rather at the tardy recognition of their great advantage over the ordinary settings. The expense of the full-depth producers, and even o the semi-regenerative settings, has kept many managers of small works from adopting them. However, our friend, Mr. Reid, of Longford, will to-day give us his experience with a setting which is within the reach of all, as far as expense goes. As we shall have a further opportunity of reverting to the subject of retorts, let me only remark that the one drawback to high heats is choked ascension-pipes. In a communication to the *Journal of Gas Lighting* of the 1st of August, Mr. S. Carpenter states that he is about to offer a new style of main which will, he believes, reduce stoppages to the extent of 70 to 80 per cent. This is good news indeed; and Mr. Carpenter, who already deserves well at the hands of the gas profession for his many lucid and instructive articles, will have earned the everlasting thanks of managers and stokers alike.

Condensation in most small works—and, I am afraid, in many of our larger works as well—is pretty much left to take care of itself. It has often struck me that, with the trouble expended in securing a gradual cooling by means of foul mains, &c., no general care has been taken to protect the washing and purifying plant from climatic changes. Recently I noticed a case of a works amply provided with thermometers, valves, &c., where the gas was entering the condensers at 80°, and leaving at 86°. I do not see how, without infinite trouble, the temperature of the gas when leaving the condensers can be constantly maintained at 55° or 60°; and even if we did manage it, I fail to see the advantage of maintaining it at that temperature, if we immediately afterwards bring it into contact with water possibly very little above freezing point, and thence through purifiers and into holders fully exposed to all the changes of our climate.

I am glad to see a general improvement in the washing plant throughout our works. Many of the washers on the market are very compact and effective; and nothing can be more advantageous in regard to purification than effective washing. One matter, however, is worthy of consideration in small works—*i.e.*, back-pressure. Many washers cause much back-pressure; and where there is no exhauster, it is a great disadvantage—especially with high heats. Managers should bear this in mind when considering the merits of washers,

I have very little to say regarding purification. Thanks to the many instructive articles that have lately appeared in our technical journals, we have a clearer idea of the chemical action that takes place in the boxes. The main consideration is to have ample area to get the full efficiency out of the lime.

I presume it is on account of the cost of gasholders that we find so few of our works with anything like adequate storage. This, undoubtedly, is one of the greatest drawbacks to successful management, in addition to being a constant source of danger and worry. Some works I know have not storage for two-fifths of the maximum output. This necessitates extra furnaces and retorts, with corresponding loss of coke, additional wages, and wear and tear of plant. Nothing can be more annoying than to have to reduce the pressure in the evening, when the retorts have been lying idle all the forenoon.

I do not know that I need make any remark regarding prepayment meters and cooking stoves. I am afraid, after the poetically-embellished articles that appeared in our journals some time ago, there is little that could be added that would not seem insipid. At the same time, we are glad to welcome the author of these articles to our shores in a business capacity. There is a large field for manufacturers of cooking stoves; and our profession, as a whole, is bound to share in the enterprise and success of these manufacturers. One of our members last year prophesied that the penny-in-the-slot meter would yet be the backbone of the gas profession. I think, in some of our industrial towns, this is already the case; and in most other towns the custom derived from this class of consumers is no inconsiderable portion of the total.

To-day we are to have a paper on our "financial relations" with our consumers, in the form of differential rates. I hope this question will be debated upon a broad basis, and that all our members will speak their minds. Personally I approve of differential rates, as a means to an end—that end being the reduction of the price of gas all round, by reason of the economy resulting from increased manufacture. I do not contend that we ought to sell gas at a loss; but, if necessary, I would be prepared to sell at a very small margin above cost price, rather than lose a customer. When we find electric light companies catering for motive power at 1d. per unit, as I believe is done in Manchester, it behoves us, as intelligent business men, to make hay while the sun shines as well as when it is not shining.

I think some managers are too much inclined to under-estimate the electric light. To my mind, this is a mistake. Undoubtedly

our position is secure for many years to come; but with so many able scientists constantly experimenting, and electric traction gaining a powerful foothold, the cost of generation will not increase, neither will the industry fall back. Let each and all of us, therefore, do our best to make the position of gas manufacture secure; and, in sporting phraseology, do not wait until we are "caught in the straight" before we "come away."

In the "Electrical Review" of the 28th of July, there appeared an article describing a new gas-engine manufactured by the Westinghouse Electrical Company. This firm, who are the leading Electric Traction Company in America, are opening works in Manchester, backed by a capital of £1,500,000, and with Lord Kelvin as adviser. This engine will form one of the staple manufactures of the Company. The chief claims put forward on behalf of the new engines are better governing, better admixture of gas and air, and regularity of explosion. There will be no "hit and miss" about them, and consequently none of that fluctuation in the lights which has been the great drawback to gas-engines as a means of driving dynamos. These engines are largely used on the other side of the Atlantic for generating electricity, and are being made up to 1500 brake horse power.

Last year we had an excellent paper on the "Workmen's Compensation Act," from our esteemed friend Mr. Gibb. I am glad to notice that we are now having offers of insurance at 5s. per £100; and I daresay this will be reduced still further when Insurance Companies find how comparatively few accidents occur in gas-works.

The Gas Institute took no action with regard to the standardizing of meter-unions. I understand, however, that the meter manufacturers are considering the matter with a view to uniformity.

As I stated at the beginning of my address, we receive very small prices for tar and liquor in Ireland. Whatever tar cannot be sold locally has usually to be burned. Fortunately, I have always managed to get over 1d. per gallon for my surplus tar; and this I consider its equivalent as fuel. This being a purely grazing district, and the soil being so rich as to require little or no artificial manure, we gas managers have small inducement to start the manufacture of sulphate of ammonia. There seems however, to be an inclination in many quarters to revert to tillage, if not for increased profit to landlord and tenant, at least for the benefit of the community as a whole, by increasing the population and developing the resources of the soil. Should

any general movement in this direction take place, we gas managers situated in the grazing districts are bound to benefit by the change; and it is to be hoped that the splendid prize essay on the "Utility of Sulphate of Ammonia in Agriculture," by Mr. James Muir, M.R.A.C., which recently appeared in the *Journal of Gas Lighting* will be published in cheap pamphlet form, so that it may be largely circulated among the farmers and agricultural experts.

We have all heard a good deal lately about the extraordinary results obtained from "intensified gas-light"—a burner consuming 10 cubic feet per hour under a pressure of 9 inches yielding a light equal to 300 candles. The pressure is produced by a water pressure-increaser; and I have it that for an installation of 30 lights the cost would be about £50, exclusive of burners. We are promised another pressure-increaser in the form of a hot-air motor; but whether this would be cheaper than the water power I am not at present in a position to say. I have had great satisfaction with the new No. 4 incandescent burner. It is really a splendid light when there is a proper adjustment of gas and air supply. I keep a small stock of nipples, and adjust all burners to meet the requirements of the various pressures.

And now, in concluding this address, abounding in platitudes and imperfections, let me congratulate you and our worthy Secretary on the flourishing condition of our Society. It is a great matter for satisfaction to find our Association being so largely availed of by the southern managers; and it is a question whether the Association might not now fairly claim to represent the whole of Ireland. No one can deny that it has made wonderful progress during the twelve years of its existence. Like most other Associations, it has had its periods of trial; but, on the whole, since the time when some twenty managers, on Mr. Whimster's invitation, met in Armagh and formed the Association, it has fulfilled, in a remarkable degree, the object for which it was founded—viz., to encourage and advance all matters connected with gas engineering, and to facilitate the exchange of information and ideas among its members. Scattered as we are throughout the length and breadth of the land, with long distances often separating the various towns—in my own case, my nearest neighbour is some 26 miles away—we have few opportunities of comparing notes with each other; and it is only at certain intervals that we can meet together for mutual benefit. Who does not feel enlightened and stimulated by the annual gatherings of our Association, by the practical papers on every-day subjects, and by the lectures by such prominent

Chemists as our learned friend—for he has been a friend indeed to our Association—Dr. Tichborne, and Professors Lewes and Macadam.

Our past President, Mr. Nisbet, of Portadown, last year spoke wise words when he said, "Let no one think he has already learned as much of his business as he will require; for in this progressive age something new is turning up almost every day." These are true words; and anyone who reads the transactions of our several Associations must be struck with the variety of subjects with which gas managers must be conversant. Like our Navy, we have to be ready and able for any rival or combination of rivals. We are now at close quarters with paraffin, coal, and electric light; and I think we may rest satisfied with being able to give a good account of ourselves. Shall I be considered a visionary if I say we are only at the beginning of the possibilities of our industry, and that as time goes on, and our knowledge and education advance and competition becomes keener, we shall ultimately direct our energies to the more profitable disposal of our tar and liquor, in the form of carbonate of ammonia, anthracene, carbolic acid, sulphuric acid, dyes, &c.? I fancy most of us consider we have quite sufficient worry without undertaking further responsibilities. I only mention these products to show what a large field for enterprise still remains practically untouched.

Lecture by Professor Tichborne.

Professor C. R. C. Tichborne, LL.D., F.I.C., &c., of Dublin, then delivered the following lecture:—

ON THE CONTINUOUS MODE OF TESTING GAS.

In 1892 I had the pleasure of addressing this Association "On the Value of the Bye-Products of Gas-Works, and on Improved Methods of Estimating Them." I then dealt chiefly with the Metropolitan Gas Referees' methods for the estimation of ammonia and the total sulphur. I propose now to give you what, if you like, you may consider to be a continuation of that subject; but I should say at once that it only touches upon the estimation of ammonia.

In the previous paper I pointed out that a great change had occurred in the position since the days when the Referees first made their regulations. At that period it was only a question of providing against a very high percentage of ingredients which were then viewed as impurities. But now the manufacturer of gas finds these substances of such commercial value that he

displays the greatest anxiety to separate them as far as possible from the gas. If he is not getting his proper proportion of ammonia and sulphur, it is so much money lost. In most cases he has to sell the bye-products on the unit of sulphur or ammonia which they contain; and so the estimation of these substances has become a question of the highest importance to him.

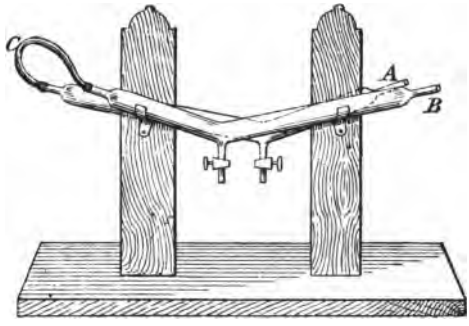
Now the following is the *modus operandi* of the Referees' process for ammonia. A volumetric or standard solution of sulphuric acid is taken; and a measured amount of this solution is placed in a glass cylinder filled with glass beads, and provided with a tap at one end. At this point comes in a possible source of error. Some scientific instrument makers send out an apparatus filled with common beads made of soft glass, that so act upon the sulphuric acid as to render experiments quite useless.

But to resume. This cylinder is not easy to manipulate. You have to insert the exact quantity of volumetric acid into it, and, after closing the tap, turn the cylinder round and round until the whole surface of the beads is well covered. Not only does this require careful manipulation, but at the end of the operation it is difficult to wash out the cylinder so as to be quite certain that you have removed all the contents. If the washing be imperfectly done—say, from haste or careless manipulation—the determination is hopelessly wrong.

After charging the cylinder with the acid, the gas is slowly passed through it—say, at the rate of 2 cubic feet per hour—until the 10 cubic feet have passed. The ammonia in the gas is of course, at once arrested or neutralized by the sulphuric acid. The contents of the cylinder and washings therefrom are then to be estimated by a volumetric solution of ammonia; and the difference between the volume of ammonia solution which would be originally required by the acid used, and the volume absolutely used after passing the gas, represents the ammonia which has been absorbed from the 10 cubic feet of gas. This may be said to be a concise description of the process—sufficient to remind us of the points requisite to compare with the process I am now about to describe in detail.

This process involves no manipulatory trouble, is not performed by isolated experiments, and requires no volumetric estimation. If a few simple precautions are taken, the process is absolutely correct. It is essentially a process of saturating a standard solution of acid, but only thus far does it resemble the Referees' process. I pass the gas through two absorption tubes of a peculiar shape. Let us call one A, and the other B. These tubes are very simple, are specially suited for gas washing, and

do not produce any back-pressure. Each tube has two limbs, so placed as to have a slight angle to each other—say, an angle of 150°. At each end are narrow inlet and outlet tubes respectively, which can be connected by india-rubber tubing the size of a quill to the gas supply, &c., as required. The short limb is the inlet, and the long one the outlet. The two tubes are placed on a stand, and the outlet of A connected with the inlet of B. At the angle of the two limbs is a stopcock, by which the tubes can be emptied. As thus arranged, they are ready to work. Ten cubic centimetres of standard acid are introduced into each tube; and the gas supply is connected with the inlet of A, and the experimental meter with the outlet of B. The gas is then allowed to



A. Gas Inlet. B. Gas Outlet. C. India-rubber Connection.

Fig. 5.—Professor Tichborne's Absorption Tubes.

pass slowly. The standard acid acts as a trap at the bend of the tube. In fact, the gas keeps forcing the liquid up the tube; and as the liquid keeps falling back, a constant movement of liquid and gas is maintained.

It will now be necessary to describe the volumetric solution. I prefer to make it so that each 5 c.c. = 0·00064 gramme, or 0·01 grain, of ammonia (NH_3). It is prepared in the ordinary manner—which I need not trouble you with now—or it can be prepared at any of the establishments which make chemical tests. But before making up the final measure, half a grain of methyl orange to each litre should be added. This solution should be made up to its final volume at 60° Fahr. Such a solution is bright red. Methyl orange is supposed to be the most appropriate indicator for ammonia.

Now, as the gas slowly passes through the tubes, you get a point when the tube A becomes yellow, instead of red. You know that the gas passed has contained sufficient ammonia to represent 0·02 grain, the equivalent of your 10 c.c. of acid, and

you note the volume of gas registered. The saturated standard solution is now removed by the tap from A, and a fresh 10 c.c. introduced. At the same time we now connect B with the gas, and let A become the outlet to the meter. The object of this is that any traces of the ammonia which might possibly have escaped A are now locked up in B. So the experiments go on continuously; it being only necessary to have a note-book, ruled in three columns—one for the date, one for the measure of the gas, and the third for the ammonia. Thus—

Date.	Gas in Cubic Feet.	Ammonia in Grains.
Aug. 1.	9·8	0·02
,,	8·7	0·02
,,	6·8	0·02
,, 2	8·0	0·02
,,	7·7	0·02
,,	7·9	0·02
,, 3	7·1	0·02
,,	8·0	0·02
,,	8·1	0·02
,, 4	7·7	0·02
,,	8·2	0·02
	78·2	0·02

Therefore $\frac{200}{78{\cdot}2}$ = grains of ammonia per 100 cubic feet of gas.

Thus, neglecting the first experiment, 78·2 cubic feet of gas contain 0·2 grain of ammonia, or 0·25 grain in 100 cubic feet. The first experiment is neglected as it contains a slight error—*i.e.*, the small amount of gas carried into the tube B. Therefore it would be better not to consider it as an individual reading.

In mentioning the volumetric solution, I stated that it should be made up at a temperature of exactly 60° Fahr., because, as I have mentioned before, dissociation of ammoniacal solution by heat is so marked that very exact results can be obtained only by working at uniform temperatures. The following is the difference I have found on an estimation of ammonia at different temperatures, and using methyl orange as the indicator:—

50° Fahr.	0·1000 grain of NH_3.
55° ,,	0·1000 ,,
60° ,,	0·1000 ,,
65° ,,	0·1010 ,,
70° ,,	0·1020 ,,
75° ,,	0·1024 ,,
80° ,,	0·1032 ,,
90° ,,	0·1040 ,,

It will be observed that there is no practical change at low temperatures, but that change is apparent above 60°. Congo red is a good indicator to show these reactions. The methyl orange is the best indicator for use. Phenolphthalene and litmus are inadmissible, because the ammonia comes over largely as

carbonate; and these indicators are not reliable under such circumstances. Sir William Crookes's colorimeter, for determinating shades of colour, might be used with advantage in fixing the point of neutrality.

In conclusion, I may mention that the principle enunciated here is applicable to many estimations—such, let us say, as to the carbonic acid. I have used divisions which I consider more scientific; but, of course, it is merely a question of transposing, if "septems" are preferred.

Mr. S. B. LANGLANDS (Coleraine) asked the members to accord to Professor Tichborne the heartiest thanks of the Association for his very able lecture.

Mr. C. B. OUTON (Inchicore) seconded the proposition.

The PRESIDENT said he had very much pleasure in conveying the thanks of the meeting to Professor Tichborne.

Professor TICHBORNE said he was very much obliged to the members for the kind and hearty way in which they had received his lecture.

Mr. S. B. LANGLANDS (Coleraine) read the following paper:—

NOTES ON BUILDING CONSTRUCTION IN SMALL GAS-WORKS.

My subject is one on which very little new light can be thrown, more especially by a tyro. However, I fancy that, in discussing my attempt, some of my colleagues in the profession may reiterate some accepted truths. As the author of "Dreamthorp" aptly puts it, "The world is not so much in need of new thoughts as that when thought grows old and worn with usage it should, like current coin, be called in, and from the mint of genius re-issued fresh and new." That this rejuvenation may be accomplished by my brother-members, is my hope. My intention is to deal almost exclusively with what I may call the "umbrellas" or coverings of our works—commencing with the coal-store and going beneath the other umbrellas as I proceed.

In the construction of a coal-store, ground of sufficient area must be covered to admit of the storing of at least four winter months' supply of coal; as in these times of strikes and other labour troubles, also when vessels are as scarce as they were last winter for the conveying of coal, many anxious minutes are ours if we arrive at our last 50 tons. Making the walls of the store of best hard-burned brick, 14 inches for the first 9 or 10 feet, and 9 inches for the remaining height of the building, is ample thickness; a buttress being placed outside every 15 to 18 feet. This buttress may be constructed in such a way as to give an

artistic finish to the building, and is a saving both in labour and bricks. It makes a better and stronger job than if the walls are made thicker throughout. The roof having ordinary queen-post principals may be slated; the purlins being set at 10½-inch centres. Or if money is not too plentiful, corrugated-iron may be used; and this, if well put on and painted with red oxide each year, looks exceedingly well, and is not the eye-sore which æsthetic beings declare. Skylight frames may be made in the roof, and glazed with ¼-inch rough rolled glass. The floor should be made in such a manner as to be at all times perfectly dry, as spontaneous combustion is a resultant of damp. In the *Journal of Gas Lighting* recently a small paragraph advocated iron plates for flooring; but this and Caithness flags would be too luxurious for small gas-works. Ordinary fireclay bricks, after having been used in our retort-settings, if neatly causewayed, make an excellent floor; and, cheaper still, if a bedding of hard burned bricks broken into pieces of about 3 inches diameter is put down, and a tar and breeze covering put on, a floor of surprising quality is obtained, both as regards its durability and the ease with which shovelling can be done over it.

In the selection of a site for a retort-house, the nature of the subsoil should be carefully looked into, as although at the time ordinary settings of retorts are to be erected, at some future date regenerative systems may be wanted; and if, when excavations are commenced, water is found, it spells endless trouble if not cessation of the work. The foundations for all walls of the retort-house—yes, and for all buildings—should be very carefully put down, and excessive rather than skimped. For instance, an 18-inch wall, 20 feet high, should have a foundation 3 feet deep, with a breadth which would leave 1 foot of scarcement on either side. If the retort-house is to be built in brick, then 18-inch work should be carried to the height of the bench, and 14 inches above that—all built in English bond, with close key-drawn joints. The roof, we know, must be of iron and steel throughout, and the slates fixed to purlins with either copper-wire or lead nails. The nature of the principals being of necessity determined by the span of the roof, I cannot advocate any special arrangement thereof. However, no great space should be specified between them, as our roofs have many times to bear extraordinary strains; for it is a very common practice to place our new retorts in position in the ovens by means of a plank resting on the principals, with a block and tackle in the centre. For this reason, I would also advocate a longitudinal tie-rod connecting them together, and affixed to

wall-plates in the gables. A ventilator should extend along the greater part of the roof, and be constructed in such a manner as to allow all smoke, &c., to escape, and yet not to allow down-draughts of cold air. Plenty of daylight in the retort-house is not, I am afraid, a usual thing; in fact, one would think the window-tax was still in force from the dim religious nature of the light in many of these buildings. Why is this? In many cases, windows seem to have been almost entirely forgotten during erection; and what small glazed openings there are, are usually much in need of a rub. Now our deeds are not deeds of darkness; so henceforth admit light, and keep our retort-houses as clean and cheery as possible.

The exhauster-house may be a neat little building wrought in 9-inch brickwork, as the walls here have not to stand any strains. The roof to be wooden, and slated, with a revolving ventilator to it. A good deal of finish should be put on this little building, as it is one of the few which allow of this being done in a gas-works. The insides of the walls may be sheeted and varnished, and the doors glazed on the top half. A concrete floor should be put a few feet from the wooden floor level, so that all the connections may be at all times accessible. This lower floor should be made with a fall to a grating set therein, so that all condensed steam, oil, &c., from the engine may be led into the drainage system. The wooden floor should have an open-work iron grating, 6 inches broad, let in all around the base of the engine, so that oil spilled, &c., may get away.

The lime-store needs only to be well built, well roofed, and well ventilated. A large door must be made to allow the lime-carriage to enter and leave in its journeys to and from the purifier-house.

The purifier-house—to be Irish—must be no house at all, but only a roof supported on beams and iron columns. This question of closing in the purifiers has been discussed time and again; and although accidents have occurred, demonstrating the folly of completely closing them in, advocates are still to be found for this system. A beam should run along the whole length of the house, of sufficient strength to allow the purifier-covers to be suspended from it, and the lime-carriage to travel along when cleaning and recharging are being done. The ground around purifiers should be concreted, to allow it to be decently cleaned up after the emptying of a purifier.

The meter and governor houses should be finished similar to the exhauster-house; and the valves for the holders should be placed inside one of these houses.

I only want to speak of one or two small points ere I close. In the "daily round" a hundred-and-one things crop up to be noted; and if these notes were now and again given to us at these meetings, I fancy they would be more beneficial than deep lectures on abstruse subjects.

One of my notes is relative to my anxiety with a chimney stack. In the construction of the works, the stack was placed inside the retort-house walls; and in its oscillations it pushed the walls out all round it until at present a gap of a foot wide yawns between it and the east wall. As the chimney has become reduced to a mere shell of 4½-inch brickwork, it is to be taken down, and a new one erected on some vacant ground adjoining the works. Before the state of the chimney was discovered, I was busy speculating as to the best means of dissevering it from the walls, and had in my own mind determined to free all the walls from the chimney and make an apron of zinc work affixed to the stack, and extending over the roof, to throw off the water.

Again, the exhauster and meter houses had been built with very poor mortar; the joints were open and ugly. Well I put one of my men to work picking out all the joints, pointing them with cement, and key-drawing them all with a steel key, which I got made for the purpose.

In preparing the plans and specifications for one of my jobs I came on the following table, which may be of use to some of you in your constructional works: To find the number of bricks required in building certain lengths, &c., of walls. Take out the superficial area of all the walls in square feet, arranging them in groups according to their thickness—*i.e.*, so many square feet of 9 inch, so many of 14-inch, and so on. Then deduct the areas of doors and windows. Then multiply the areas so obtained by the following figures: If half-brick thick, multiply by 0·0053; if one brick, by 0·0106; if one-and-a-half bricks, by 0·016; if two bricks, by 0·0213; if two-and-a-half bricks, by 0·0267; and if three bricks, by 0·032. The answers will be the numbers of bricks required in thousands.

Discussion.

The PRESIDENT was afraid they could not all carry out their ideas; but it was good to have high standards before them, so that if they had the opportunity they might be able to do so.

Mr. J. NISBET (Portadown) remarked that he had a chimney built into the retort-house, and it bulged, with the result that they had to pull it down.

Mr. J. RICHMOND (Kilkenny) said he did not consider there

was any necessity for having the retort-house roof of iron. He did not see any reason why it should not be of wood.

Mr. T. WHIMSTER (Omagh) suggested, as difficulties, that if there were shafting, probably the wall proposed by Mr. Langlands would not be strong enough; and that if they put concrete round the purifiers they would not be able to get at the pipes.

Mr. H. KIRKHAM (New Ross) said very few managers of small gas-works got what they wanted. He only wished he could get some of the things he would like. He recently had to take down a shed because he found that the steam had rotted away the galvanized iron roof. It was a coke-shed, and he had put up a roof of wood, with felt. He knew the roof of wood and slate upon his retort-house was the best in the whole works.

Mr. B. WILLIAMSON (Clones) thought the chimney was often a difficulty in old works. He instanced a case in which one was part of the gable, and the gable part of the chimney; and it very nearly came down before they could get it pulled down. Anyone who put up a chimney which was not separate from the building would certainly have a collapse.

Mr. F. EUSTACE (Tullamore) said a sheet-iron louvre was placed on his retort-house eight or ten years ago. It recently required to be looked at, and they then found that a good deal of the copper wire work binding the slates on to the ribs required repairing. Nothing was holding the slates except a little cement. He should like to know what would be a good substitute. Lead nails had been mentioned; but he had not had any experience of them. He expected to have to ask his Directors in a year or two to put a new roof to the retort-house; and he wished to know what would be the best method of binding the slates, because he found that the acid acted upon the copper wire.

Mr. WILLIAMSON said he took down an iron roof, thirty-five or forty years old, and found it was, in point of fact, nearly as good as when put up. He was afraid that the copper wire of which Mr. Eustace had spoken must have been of inferior quality.

The PRESIDENT thought the copper must have been a little inferior. Where a retort-house was large enough, he would have no objection to an iron roof; but in a small house he thought such a roof was unprofitable.

Mr. J. G. TOOMS (Carrick-on-Suir) said that at Waterford recently a roof was put over the sulphate of ammonia plant, and they used aluminium nails to fix the slates, with the idea that the foul gases would not rot the nails. Of course, they could scarcely do that in small works.

Mr. LANGLANDS returned thanks for the way in which the

members had received his paper and discussed it. He thought that if they had had his trouble owing to a wooden roof over the retort-house taking fire, which it had done time and again, they would know which to prefer. He had seen twenty or thirty iron roofs, and he must say he preferred them to anything else. For putting slates on, he thought they should have lead nails 5½ inches long by ¼ inch diameter, head ⅜ inch by $\frac{1}{16}$ inch thick, and bent round the end of the slate. They would observe that he did not speak of galvanized iron roofs for retort-houses; he kept away from that. His idea was to have cement 4 feet broad round the purifiers; and they would not mind it to that extent, seeing that it would enable them to have a thorough cleansing of the purifiers, which were not the cleanest things they had after having been in use for some time. Aluminium nails would be very good. He had been troubled with his pumps getting out of order; and he procured an aluminium pump, which had overcome the difficulty arising from the action of the acid.

Mr. W. A. REID (Longford) then read a paper entitled:—

THE WORKING OF A SEMI-REGENERATIVE SETTING.

Having had a few years' experience of a setting of retorts on the regenerative principle, I thought it might be of interest to my brother managers of small works to make some remarks thereon. Some six years ago, I got my Directors to consent to my removing two benches of threes, and erecting a new bench of fives, 21 inches by 15 inches by 8 ft. 6 in. In due course the bench was erected; and I thought we would have smooth sailing and a profitable year. When the time came round that this bench was required, a fire was put under, and heat got up slowly. At the end of a week, however, the heat was not what it should be; and I tried everything I could think of to remedy matters. But try as I might, the heat would not get more than a dull red. We worked on in this fashion until the pressure of work made things unpleasant; and it was then that I thought of trying what tar-firing would do. Having one of Walker's tar and steam injectors at hand, I set it to work, and in a short time there was a great improvement in the heat, which enabled us to get over the busy season. Not wishing to put in another winter with the same setting, I was on the look-out for something better and more profitable; and at last I decided to erect the setting which is the subject of this paper.

During the following summer, I pulled down and cleared out the whole setting, and excavated below the floor-level about 3 ft. 6 in., and put down a good concrete floor, perfectly level, to

within 2 feet of the ground-line. I then started from this floor to run up the air-channels, of which there are four on each side of the furnace walls. On the top of this air-chamber, the main flue was built, and the bottom retort placed in position. The furnace walls were carried up to the centre of the bottom retort, and in each of the walls were two nostrils conveying the heated air to the furnace. I should mention that the cold air passes in through an opening in the front of the bench at the floor-level and

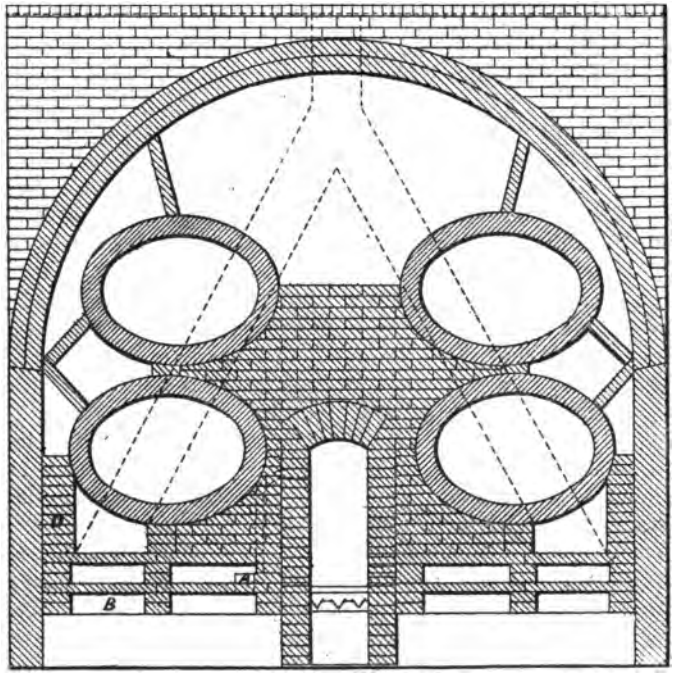


FIG. 6.—SEMI-REGENERATIVE SETTING AT THE LONGFORD GAS-WORKS.

on to the bottom air-channel. Four arches are thrown over from side to side of the retorts, and rest on the top of the furnace wall. A single brick on flat is then laid on the top of the bottom retorts, from front to back; and the upper retorts are laid on this bed, and the walls between the retorts continued up to the level of the top retort—having the arches as their foundation. Single bricks on end are placed here and there between the retorts and the side of the oven, to give strength

and to keep the retorts secure. A baffle-wall is built on the top of the retort, from the front to within 2 feet of the back wall. It consists of bricks or tiles on edge, and made tight so that no heat can escape direct to the waste-gas main flue until it first travels the entire length of the bed.

By reference to the drawing you will observe that the cold air enters at A, an opening in the brickwork at the front of the bench, 4½ inches by 2½ inches, and travels to the back of the oven; and crosses to B, and on to the front of the bench. The air then rises to the next channel, and on to the back; crossing over, and on to the front. It is then conducted by two small passages to the furnace, where it unites with the furnace gases and generates an intense heat, which rises to the top of the arch, and there disperses evenly round the retorts. The baffle-wall does not let the heat away too quickly, but compels it to travel to the back of the oven, where it crosses over the upper retort, down the sides, and on to the front, at D, into a wide flue under the bottom retort, and then into the main flue.

I do not know that I can say more about this setting, further than mention that it has been a great comfort to the men and myself, and a great source of profit to my Company. Saturday being our heaviest night, the men had formerly to work if anything harder on Sunday than other days of the week; but with this setting, they can get six hours off on Sunday.

With regard to the furnace, I have three angle-bars, 4 ft. 6 in. long, resting on two metal cross-bars, with V notches to hold the bars in their place. A small iron pipe conveys water to the bars, which is constantly running down them. As the bars are 3 inches lower at the back, the water runs the entire length, and keeps them cool, and also prevents the clinker from becoming hard. There is thus no trouble in cleaning out the furnace, which takes place every second day in winter and every third day when the work is lighter. The ash-pit is large and deep, so as to hold a quantity of water; and, of course, it must be rendered water-tight.

This setting takes a very small quantity of coke to keep up the heat, as compared with the former settings I had. To fill the furnace requires 2½ cwt. of coke each time; and the furnace is filled four times in the twenty-four hours.

I do not claim anything very original in this setting; but for managers of small works I do claim that if they adopt a setting on the principle I have tried to explain, they will add to the revenue of their companies, to their own credit, and last (but not least) to the comfort of their men.

Discussion.

The PRESIDENT said he trusted that Mr. Reid's paper would bring out a good discussion, and that members would speak their minds fully on the matter dealt with.

Mr. J. LYNE (Wexford) asked Mr. Reid to explain where the secondary air entered, and where it met the gas and the combustion took place.

Mr. REID gave the explanation on the diagram, and said the whole system was very simple, and was easily worked.

Mr. TOOMS thought there was something wanting in the paper. He wished to know what was the make of gas per mouthpiece per 24 hours.

The HON. SECRETARY said he had no experience of regenerative furnaces, or even of such a system as Mr. Reid had shown them, because in his place they could not drive a yard steel bar into the ground without getting into water; but he believed in a secondary air supply, even with ordinary furnaces. He put in three ovens of six retorts each, on the ordinary system; but he had very unsatisfactory results. He found that he could not get anything like a heat out of the lower retorts on each side of the furnace; and it seemed to him to be foolishness to charge them. He took them out, and put in a secondary air system; and he found that by this system he could get far more gas out of the four retorts than he had formerly done out of the six. He was not prepared to give the figures, because he did not think of speaking on the subject; but his plan was a very simple one. His retorts were ⌂ shape. The main outlet-flue went along on the ground-level. By taking away the bottom retorts, he had room for double flues; and he got all the heat for the secondary air from the waste gases after they had done their work in the oven. It was an easier mode of heating, as well as more regular and stronger all over the setting; and he could work off more coal in the time.

Mr. LANGLANDS offered his thanks to Mr. Reid for his able and clever paper. He would be pleased, however, if the author would give them plans—sections as well as elevations—of the setting. He did not know if he was right in saying Mr. Reid spoke of allowing cold water to run down the bars of the furnace; but, if so, he would suggest that putting steam there, instead of cold water, would be better.

Mr. KIRKHAM said he should like to get full particulars of the size of the flues, because he found that in a setting of fours, somewhat on the same style, the flues clinkered up, and the process was simply useless.

Mr. R. HARRISON (Wicklow) remarked that two years ago he put in a setting of threes, somewhat the same as this one, and last year one of fours; and he found he got more gas out of the former than from the latter. The only difficulty he had was in the putting in of a piece which dropped clean out of one of the flues.

The PRESIDENT said he had had the pleasure of using one of these settings. His floor was not the same, because the bottom of his retorts was very low, and he had to go underneath. He found that the heats went down, more or less, after clinkering; but he thought this was rather on account of having to stoke up with cold coke. He was having a small barrow made, so that the furnace could be charged with hot coke. He did not think it would be a fair criterion to simply state the quantity of gas made per mouthpiece, without giving the size of the retorts. Many of them had retorts 8 feet, and others 10 feet long. He was strongly in favour of the latter, because there was always about 2 feet at the mouth in which they could not get the heat up.

Mr. REID said he could not exactly state the quantity of gas made per mouthpiece per 24 hours, but his average make during the twelve months was 10,200 cubic feet per ton of coal. He thought this was a very fair return, considering the works were small ones. In the first year of his working the system, there was a closing up; but in the second year he raised the air-holes and kept the coke away from the entrance, because it was the air rushing through the coke that created such a heat that the bricks were melted. The setting had worked for nearly three years. He had no fractures at the air entrances, because he made certain that the cold air would not strike upon any part of the setting unless at the nostril. They had made an extra profit of between £80 and £90 a year by the process; so that it spoke for itself.

The HON. SECRETARY, in the absence of the author, read a paper by Mr. R. B. ANDERSON, of Westminster, entitled :—

IN FAVOUR OF DIFFERENTIAL PRICES FOR GAS.

I am induced to bring this subject before you, because I consider that, under certain circumstances, the system of having differential prices is attended with satisfactory results to both shareholders and consumers, and also because the case against the system was so forcibly expressed recently at the Gas Institute meeting by Mr. Thos. Newbigging, whose opinions many of us are perhaps too apt to adopt (without questioning their application),

in consequence of the authority with which he is entitled to speak. In all cases, however, we should bring reason to bear upon the merits of our own particular circumstances.

In addressing my present audience, I am assuming that most of us are connected with towns in which the price of gas is necessarily high. Few of us have anything to do with gas under about 5s. per 1000 cubic feet; most of us know a good deal about prices running up to 6s. and 7s.; and a few of us, at the other end of the scale, have difficulty in making both ends meet with prices bordering on even 8s. Of 80 towns in Ireland of which I have statistics, I find 61 charge 5s. and over; 40, 5s. 6d. and over; 31, 6s. and over; and 14, 7s. and over.

In his paper read to the Gas Institute, Mr. Newbigging dealt mainly with comparatively speaking low-priced gas. To-day I am referring chiefly to high-priced gas. It is to those having to charge the higher prices that the adoption of differential rates becomes of most advantage. As the ordinary price is less, the advisability of having differential rates becomes less, until you reach a price which admits of no abatement being made profitably.

In considering this question, managers generally associate it with extending the so-called "day consumption;" but I consider this, to a certain extent, a fallacy. If you could draw a line between consumption during hours of light draught and hours of heavy draught, as was for a time tried in Brussels, there would be some reason in it. But it is a mistake to call engine and cooking gas "day consumption"—used while mains and holders would otherwise be idle. During mid-winter, lighting, engines, fires, and cookers are in full swing together during the working hours of darkness—necessitating larger mains and holders than would have sufficed if gas were supplied for lighting only. Of course, in so far as such gas is used during the hours of daylight, an advantage does accrue from it, on that account, by keeping make and issue more evenly balanced; but in computing its cost, we are not entitled to altogether ignore capital charges for mains and holders.

I prefer to associate the question with "additional consumption," as I consider that is how the difference chargeable comes in; and differential rates are profitable chiefly because they enable one to sell more gas which otherwise would not be sold at all.

Let us now consider the cost of gas. I do not intend to burden you with many figures, but to succinctly summarize them. I would ask you not to criticize the figures themselves,

but merely my application of them. I have analyzed the cost of gas in a certain town so:—

Pro ratâ charges per 1000	15	pence
Reducible charges per 1000	26	"
Profit to pay capital	39	"
Selling price	80	pence = 6s. 8d.

In the "*pro ratâ*" charges per 1000, I include coal, less products, *plus* purifying material and bad debts, because, quite irrespective of the quantity of gas made, the value of these per 1000 feet remains nearly constant. In the reducible charges, I include everything else except profit, because as you increase the make, the cost per 1000 of rents, rates, taxes, repairs, salaries, &c., tends to diminish.

Now what is the cost of additional gas? The *pro ratâ* charges remain approximately as before—say 15 pence. The reducible charges can be cut down to 16 pence, the figure which prevails in works of magnitude. Profit can be cut down to 1s., as any additional capital embarked will more nearly approach the cost per 1000 at which large works can be erected. For purposes of argument, I put it at about 16s. per 1000, at 6 per cent. Thus you see this particular company can sell additional gas profitably at 3s. 7d. per 1000, while their ordinary rate is 6s. 8d.—a very large margin.

If full advantage of approximating light draught and heavy draught could be taken, there would be a still further saving on the charge for profit, and also in the reducible charges. During winter, I do not see a practical way of giving the consumers a share of this saving; but I shall show later how it can be done during the summer.

Much has been written on the unfairness of differential rates. But in business, abstract justice has to give way to expediency; therefore we should not refuse benefits to the many because consequential hardships (generally more imaginary than real) result to the few. Where is there a business all the methods of which are above the reproach of being judged unfair?

No matter upon what lines you conduct your business, charges of unfairness can be sustained against you with considerable plausibility by those inclined to do so. We have recently had an excellent lesson in this in the contradictory arguments advanced against the Southern Railway Amalgamation. Truly it is that one man's meat is another man's poison. Self-preservation leads to self-interest; and, until the millennium,

I fear it will not pay for gas companies only to be altruistic in their dealings.

I was much impressed by an article, on the basis of railway charges, which appeared in a recent volume of the "Economic Journal." Railways charge the rate which the traffic will bear. We can deal on similar lines. Gas for lighting will bear a certain price against all competitors; but gas for heating engines and cookers has to face quite a different competition, and will not bear nearly so high a rate. Provided you put all your consumers on the same footing, I do not see that any one should have much real cause to complain. Gas companies charging differential rates are not the only traders to whom awkward question can be addressed. Is it fair that pater-familias and the lonely widow, who use vastly different quantities, should pay the same water-rate because they live in similar houses? Is it fair that a railway should carry folk casually going for pleasure at a cheaper rate than their constant passengers travelling for toil? Is it fair to your old consumers who have made your business for you that when you reduce the price you should allow their competitors to come on as new consumers at a price less than you for years have been charging your old friends? I have had consumers seriously argue that they as old consumers are entitled to some advantage over new ones. Such questions can be multiplied *ad lib.*; but they only tend to show the impossibility of offering terms that will be considered fair by every party affected.

To those of you who may be contemplating a general reduction, I would suggest the following for your consideration: On your books you no doubt have many consumers who find it worth their while to burn gas at the present price, who would not be tempted to burn more by any reduction in price. If you reduce the price, you simply make these consumers a present, and look to recoup what you give to them from new consumers and old ones who increase their account. Now, by differential rates you do not make the consumers who respond to your overtures by consuming more freely recompense you for the loss on those who do not; but all the benefit of the reduction goes to those who increase their turn-over with you.

General reductions are, of necessity, small; and those of you selling gas at 6s. or over will find it a long time before you can bring down the price to one low enough to tempt consumers to use engines, cookers, &c. But if you make a large reduction for these purposes, you can get them on at once and run no risk of loss of rental. I am no believer in trifling differences of

2½ and 5 per cent. I do not think there are many of you who could not afford to sell additional gas at 3s. 4d.; and I should say do so—no matter how much higher your other price may be. At one town we are charging two prices—6s. 8d. and 3s. 4d.

Some of you may be afraid to show such differences. At first you may be inundated with complaints that, if you can sell at 3s. 4d., you ought not to charge 6s. 8d., but you can answer them with reason on your side. In one town some years ago we were selling at 6s. and 3s. 4d.; and a campaign was started against our iniquities in the local twopenny paper, which luckily had a very sensible and fair-minded Editor. I entered the lists, drew the fight from gas to papers, and showed that although it was necessary to charge 2d. for the local paper to make it pay, yet how profitable it would be if the Editor could get some of his subscribers to take a second copy at 1d.—the extra cost to him being merely paper, ink, and a little time. All present reporters, typesetters, &c., would suffice. He had sometimes been twitted for charging 2d. for his little paper—no larger than a Dublin halfpenny evening paper. I fought his case and our own at the same time, to our mutual satisfaction and the confusion of our enemies.

The usual method of differentiation is to charge one price for lighting gas and a lower price for gas used for other purposes; separate meters being fixed to register the two consumptions. To this there are several objections: (1) An additional meter has to be installed and kept in order, read, booked, and accounted. (2) Separate fittings have to be run through the house. (3) Lights are sometimes connected on to the wrong system of fittings—accidentally or otherwise. (4) Fraudulent consumers, by means of a rubber tube, can easily connect the two systems of piping. (5) In many cases the cost of an extra meter, piping, &c., more than counterbalances the difference in price of gas; and in others the nuisance of running a pipe through a house with the concomitant taking up of carpets, &c., prevents the introduction of a fire, &c., which might have been installed if it could have been connected on to the nearest pipe of adequate size.

My first experience with differential rates was on this separate-meter system; and its defects quickly came home to me. In conversation with friends working on the same lines, I found it was not at all an uncommon practice for them to get over the difficulty of the extra piping and meter by assuming that, in certain cases, when a consumer put up a stove, all the increase in his account was attributable to the stove, and agreeing with the consumer to pay accordingly. It at once struck me that

here was a way out of all my difficulties. It did not matter how a man burnt his gas so long as he burnt more; and accordingly we introduced what (for the sake of an explanatory name) I will call the "Cheap Additional Gas Scheme." We claim no novelty for this method; in fact, after we had been using it for some years, we found it had been tried and abandoned by a gas company near London some years before we started it again.

I will now describe how we introduced this system. In past records we had at hand the material for tabulating every existing consumer's account, and for estimating normal consumption for new consumers. Accordingly we tabulated a consumption for each consumer, and sent him a circular (see Form A) having an appropriate example suited to each individual worked out on it. The form of account adopted for working the system is shown in Form B.

[FORM A.]

_____ 189

*To Mr.*_____

With a view to inducing you to burn gas for other purposes than lighting, it has been decided to charge you at the reduced rate of _____ per 1000 cubic feet for all the gas you use in excess of the quantities tabulated below, which have been estimated as average normal consumptions for lighting the premises you occupy.

Period ended _____ ——— ooo cubic feet.
" " _____ ——— ooo "
" " _____ ——— ooo "
" " _____ ——— ooo "
" " _____ ——— ooo "

For example: Suppose your consumption for the current period be ____ _____ 000 cubic feet, then your account would be:—

_____ ooo c. ft. at	£	:	:
_____ ooo c. ft. additional at	£	:	:
	£	:	:
As against _____ ooo c. ft. at. . .	£	:	:

[FORM B.]

Gas-Works, _____ 189____

Mr. _____

Present index of meter.				
Index of meter at commencement of period .				
To gas consumed during period ended on above date	oo cubic feet at 6/8 net .	£		
Tabulated consumption . .	oo do. do. at 6/8 net .	£		
Additional consumption . .	oo do. do. at 4/2 net .	£		
Meter-rent for same period		£		
Amount due		£		

Of late years it has, with reason, been proposed to make a charge for "readiness to supply;" but, so far as I am aware, no gas company has ventured to do so. But what we are doing is indirectly very much of this nature. We charge for the first few thousands higher than we do for the remainder; having, so to speak, recouped ourselves for our readiness to supply. Also the system is somewhat akin to what is known as the Brighton system of charging for electricity, under which the first few hours of consumption are charged at a higher rate than subsequent hours.

You will see that this system renders separate meters and meter-rents unnecessary—no second set of pipes need be run through the house. A geyser in the bath-room, a shaving-water heater in the bedroom, a boiling-burner in the nursery, a cooker in the kitchen, a fire in the drawing-room—each or all can be connected to the nearest pipe of adequate size; or, if the existing pipes be too small, larger ones can often be run up in place of them with much less trouble than putting in separate ones would entail.

If consumers like to put up extra lights we do not mind, and the consumer has no temptation to defraud by using a rubber tube connection among his fittings.

The introduction of this scheme has entirely taken the wind out of the sails of that class of consumer which was so fond of telling us that if we would make a small reduction a lot more gas would be burnt. Now we only say to them "Burn more," and the reduction comes to them automatically.

We draw no distinction between our consumers—the smallest and largest have some of their gas at the ordinary rate; and it is entirely in their own hands whether they have any at the low rate or not.

I may say that we find some consumers slow to appreciate the system, and grumble at us still. But the following will show how foundationless their complaints are, and how carelessly made. We have had several cases where consumers have wound up their complaint by saying: "Why do you not simply have one reasonable price." We have asked them to name what they consider a fair price, and they have named prices which worked out at more than they were actually paying. The other day one said that he would prefer we charged him 5s. 6d. rather than charge our differential rates of 6s. 8d. and 4s. 2d. On it being shown to him that his account averaged out at 4s. 10d., he retired with a very satisfied "Humph, I had not troubled to calculate that myself."

Having a large consumption at low rate will eventually react upon the ordinary rate, and enable it to be lowered; but I must confess that my sympathies are chiefly with the users of the cheap gas, and I would prefer to reduce the additional gas price to nearly the minimum profitable rate before touching the ordinary price.

In 1893 a company near London, on our recommendation, adopted the system; and Mr. Livesey denounced it very emphatically in a paper he read before the Institution of Gas Engineers—prophesying that it would raise an angry feeling among the consumers. This, so far as I know, has not been the case. We find with our own consumers, it has rather tended to pacify them; and I instance the following in support of what I say: We introduced the system in one town some six or seven years ago, and last year got a new Act of Parliament without opposition—proving that our relations with our consumers are by no means bad; and, as far as I am aware, not a single individual took advantage of the opportunity to write or speak against the system either in the Press or at the Council meetings.

So far I have not suggested selling any gas at anything less than a directly profitable price. There are exceptional cases though when selling directly at a loss might be justified from expediency, in consequence of the benefits indirectly accruing. Cheap motive power may be the means of starting industries in a town. Gas companies cannot assist new industries by subscribing for shares or lending money, &c. A grocer in a town may wittingly sacrifice a few hundred pounds to get a mill or a factory started, knowing that a factory means wages being spent in his shop. Gas companies cannot take shares to help on such a company; but they can nevertheless assist by supplying at a direct loss—or even free, if they feel the loss will indirectly be made good to them.

If you lower the ordinary price by a small reduction, it takes a long time to rehabilitate your profit and loss account. A small reduction may induce a few new consumers, and some extra consumption by existing ones; but it does not offer a great inducement to a man to change his habits. If you make a large reduction though, it makes him consider the introduction of engines, cookers, advertising devices, &c. His feeling is: "The extra cost is not much—I will have it."

In one town charging 6s. 8d. we were undecided whether to reduce the price or introduce a differential rate. We made a special scrutiny of the town, and came to the conclusion that we had on our books nearly every good shop in the place except

a few who burnt oil just because they dealt in it. We inquired closely as to any others who did not burn gas, and found they fell into three classes—some who objected to gas at any price; others who would not pay deposits, and could not safely be given credit; and others whose accounts would hardly be worth having. We came across hardly any who would have been tempted to come on as consumers at even a 5s. price. In this town a few years before a reduction to 6s. 3d. had been made temporarily, with results not altogether satisfactory to the exchequer. In consequence of a rise in the price of coal, the price was put back to 6s. 8d.; and when coal fell again a 5s. rate was introduced for additional gas with such satisfactory results that a further reduction to 4s. 2d. was made three years later. The result has been that the private consumption, which was not increasing at 6s. 8d., and was hardly influenced by a reduction to 6s. 3d., has practically doubled itself in the last six years since the "Cheap Additional Gas Scheme" was introduced. Up to 1886, this company had charged 7s., and the consumption actually decreased for two years after the price was reduced to 6s. 8d. and 6s. 3d. Thus the company had reason to pause ere they made another reduction in the ordinary price.

In another town gas was sold at 6s. 9d.; and the consumption was falling. The price was reduced to 5s. 10d., which was rather an heroic step to take. The consumption continued to fall for another year; but it then slowly increased for four years, though still under what it was when 6s. 9d. was charged. We then, in 1892, introduced a 4s. 7d. rate for additional gas—further reduced to 4s. 2d. in 1896; and the result has been that the private consumption has increased by more than 53 per cent. in the past six years.

I have referred to the advantage of balancing the light and heavy draughts by augmenting the consumption during hours of daylight by getting the benefit of using our plant more fully up to its capacity for a longer time. In one town we are experimenting in this direction. Our prices are 6s. 8d. for ordinary gas, 5s. for additional gas during winter, and 3s. 4d. for additional gas during summer. I never anticipate that the hourly summer draught will exceed what our mains (designed for heaviest winter consumption) are adequate for, or that we shall ever feel during the summer that our holders are too small. We must have holders and mains to supply our winter work, a large proportion of the capacity of which is useless during the summer. The whole capital charge need not be debited against gas which will merely harmlessly flow through them. Hence a reduced charge in the

summer time is, I consider, justifiable. In this small town we have in consequence just hired out a couple of dozen cookers. We started the experiment in 1898, and had practically no complaints when the price was raised again after the summer, which was rather a surprise to us.

No one wishes more than I do to sell cheap gas; and it is because of this desire that I am so ardently in favour of differential prices.

Discussion.

Mr. C. B. TULLY (Sligo) said he must endorse all that Mr. Anderson had said in his paper. Some years ago, he adopted differential rates, somewhat on the same lines. He gave a reduction of 33⅓ per cent. discount for gas used for heating, cooking, and motive power; making their prices 4s. 2d. and 2s. 9d. per 1000 cubic feet. They started hiring out cooking-stoves some ten years ago, but had found that their consumers would not take them in when the price of gas was 5s. He saw that it was useless to go on; and so the Company reduced the price to 2s. 9d., with the result that their capital account had been reduced from £1 0s. 6d. to 12s. 6d. per 1000 cubic feet. Altogether it had been a great success. He thought that Mr. Newbigging in his paper referred mostly to large undertakings, in which they had not the same necessity for reducing the price of gas.

Mr. JOHN LYNE (Wexford) said he heard Mr. Newbigging's paper read at the Gas Institute; and he thought that he made out a very good case. In his opinion, Mr. Anderson had failed completely to prove what he had been trying to advance. Mr. Anderson certainly had been speaking of good fat prices all round—6s., 7s., and 8s. per 1000 cubic feet. It seemed to him that the difference between 6s. 8d. and 3s. 4d. to gas consumers in the same town was monstrous. He took it that there was a profit at 3s. 4d.; and if there were, what profit must there be at 6s. or 6s. 8d.? His opinion was there was a mean between what Mr. Newbigging had been contending for and what Mr. Anderson was trying to advance. He thought it would be a gross injustice to consumers who used gas for lighting—who were really the best customers—to make such a large difference in price between the charges for cooking and lighting purposes. In his own case, he had a differential rate; but he drew the line at a minimum consumption of 50,000 cubic feet per quarter for gas-engines and for bakers' plates. The prices in Wexford were 3s. per 1000 cubic feet for lighting, and 2s. 8d. for the other purposes, both prices free of meter-rent. He made no reduction

for cooking. He would like to know if Mr. Tully had a profit in selling gas at 2s. 9d. per 1000 cubic feet.

Mr. TULLY explained that Sligo had doubled their output, and 50 per cent. of the gas sold was used for cooking and cheap gas. Notwithstanding the increased output, the rents, rates, taxes, carbonizing wages, and standing charges were the same; and by improving their settings, they were able to carbonize more coal with the same labour. They certainly had a profit at 2s. 9d.

Mr. LYNE said, that being so, Mr. Tully, like Mr. Anderson, though in a lesser degree, made an enormous profit on the consumer who used gas for lighting only.

Mr. S. B. LANGLANDS (Coleraine) said he was an advocate, so far as he could go, of giving the lighting consumers any benefit there might be. If Mr. Tully reduced his price to 3s. 6d. all round, he thought it would be fairer to the consumers. He did not believe in catering for people who were not their backbone. He could not say that Mr. Anderson had made out a plausible case at all.

Mr. J. WHIMSTER (Armagh) thought that Mr. Anderson's paper was in the nature of special pleading, and that his motive was simply expediency—not a question of what was right and just, but of what was expedient. It was getting more gas to sell, and giving the manager and the men more work, for nothing. This appeared to him to be a very silly thing to do. He himself had always advocated reducing the price all round. He believed in supplying the Town Commissioners at less than the ordinary rate, because this was a method of paying for way-leave.

Mr. J. G. TOOMS (Carrick-on-Suir) said that, seeing he was employed in one of Mr. Anderson's works, he was sorry that Mr. Anderson was not present to reply to the discussion. He was not answering the discussion; but he might say that he was managing one of the works where differential rates were charged. Selling gas at 6s. 8d., they were only just able to pay their way. The consumption was going back; there was no industry; and nothing was thriving in the town. What could they do to keep the gas-works from going bankrupt, as small works were doing all over Ireland? If they reduced the price all round, from 6s. 8d. to 5s. 6d., with the same consumption there would be an actual loss. But by introducing an additional rate of 3s. 4d., they would probably retain their ordinary rental, and besides induce people to consume gas more freely for other purposes than lighting. A year ago they had four cookers in the town; there were now over forty at work, with the result

that their consumption was about 150 per cent. larger than it was even a year ago. He could not say that there were any extra expenses at all, as regarded gas-making, because his was a small works, and he had to keep practically the same staff on in summer as in winter; and it was as easy for a stoker to make 4000 or 5000 cubic feet as to make 1000 cubic feet. By having a differential rate, he was positive they had put gas into houses where it would otherwise never have been taken. One consumer who formerly only used about 2000 cubic feet was now burning about 30,000 cubic feet a year, simply because he had introduced gas for heating, cooking, washing bottles, and the like.

Mr. LYNE remarked that Mr. Tooms had contradicted himself, as he distinctly stated, in answer to a question from him (Mr. Lyne) that there was a profit at 3s. 4d.; whereas now he said they were barely able to live by selling at 6s. 8d.

Mr. J. RICHMOND (Kilkenny) pointed out that in places where gas was dear, coal was also dear, and consumers had the same advantage in the use of gas as in the use of coal. He was of opinion that the granting of differential rates for gas was very largely a matter of taking it out of one pocket and putting it into another.

Mr. T. J. COTTON (Dublin) said he had listened attentively to the discussion. He had had experience of both systems of charging for gas; and he found that the new system of giving very large discounts, and having differential prices, was one which created a large amount of distrust and suspicion among consumers. He would rather see an endeavour made to sell gas at as low a price as possible, compatible with a fair return.

The PRESIDENT thought thanks were due to Mr. Anderson for bringing the subject forward. As he said in his presidential address, he approved of differential rates as a means to an end. There was no use in their trying to introduce gas for cooking purposes at 5s. 10d., or, in fact, at any price above (say) 4s. per 1000 cubic feet. How were they to get the price down? He thought the best way was to make a slight difference. There were a great many charges—rents and taxes, for example—which might all be safely deducted; and they might still have a small profit, and be able to reduce their lighting charges too. He did not uphold the system as a matter of principle. As to local authorities, he thought they should pay for the gas they consumed; and if gas undertakings had to pay for way-leave, the amounts should go through the books of both parties in the regular manner.

As already intimated, Mr. ANDERSON was not present at the meeting to read his paper, and reply to the discussion. He, however, subsequently supplied the following notes on the various speakers' remarks: With gas at the low rate at which Mr. Lyne is able to sell at Wexford, there is little (if any) reason to resort to differential rates to increase consumption. If Mr. Langlands could be sure of having the same quantity of gas sold, and money earned, by a uniform price of 3s. 6d. as Mr. Tully earns with his prices of 4s. 2d. and 2s. 9d., of course, there would be no advantage in Mr. Tully's prices; but my opinion is that, if Mr. Tully had reduced to 3s. 6d., his present consumption and rental would not have been reached. Mr. Whimster does not follow me when he says we sell more gas at no profit. All the extra gas sold does yield a profit sufficient to remunerate the extra capital rendered necessary, and to leave some surplus over to pay something more to the manager and his men. I quite agree with the President that it is almost hopeless to do much with cookers with gas at a price over 4s.; and if gas companies now charging 5s. and 6s. adhere to uniform prices, I fear it will be a very long time ere the consumers in their towns can avail themselves of the advantages of gas cooking. On the other hand, by adopting differential prices, I feel they can immediately and profitably place these advantages in the hands of their consumers, and rapidly bring down the average price at which they sell gas below that to which they could profitably reduce a uniform price. I may add that, once we fix a tabulated consumption, it stands for all futurity, unless we have reason to consider it to have been badly estimated. We have reduced several individual cases, where consumers satisfied us their tables were abnormal.

ELECTION OF OFFICE-BEARERS.

The HON. SECRETARY intimated that the Committee had been put in rather a dilemma by the receipt of a letter from Mr. G. R. Love, of Dundalk, who, in the ordinary course, would have been proposed as President, declining to be nominated. After considering the matter, the Committee recommended that Mr. C. B. Tully, of Sligo, be elected President.

Mr. A. MACKENZIE (Edinburgh) moved, and Mr. T. FRIZELLE (Holywood) seconded, Mr. Tully's election; and the motion was unanimously agreed to.

Mr. TULLY thanked the members for the honour they had conferred upon him.

Mr. W. A. Reid (Longford) was elected Vice-President, and

Mr. J. Whimster (Armagh) was re-appointed Honorary Secretary and Treasurer of the Association. Messrs. W. Nisbett (Monaghan), Fred. Eustace (Tullamore), T. Llewellyn (Newbridge), and J. G. Tooms (Carrick-on-Suir) were elected as members of the Committee.

Place of Next Meeting.

Mr. Tully invited the Association to meet next year in Sligo; and this was agreed to unanimously.

The Name of the Association.

The President said it had been mooted to him that it was perhaps desirable to alter the name of the Association. A good many southern gas managers had come into the Association, and there seemed to be a consensus of opinion that they should have a title which would represent the whole of Ireland.

Mr. Eustace and Mr. Langlands gave notice that at the next meeting a motion would be made that the name of the Association be altered to some such one as "The Association of Gas Managers for Ireland."

Presentation to the Hon. Secretary.

The President said the next duty he was called upon to discharge was one which gave him considerable satisfaction and pleasure—he referred to the presentation to the Hon. Secretary, Mr. Whimster. As President of the Association, he was glad it had fallen in his year of office to have this honour; but, on the other hand, he was doubtful of his ability to adequately voice the sentiments of the various subscribers to the testimonial. The Association was started some twelve years ago, on the initiative of Mr. Whimster; and ever since he had acted the part of the "Guardian Angel," with a success that every gas manager in Ireland recognized. This success was largely due to Mr. Whimster's genial manner, his kindly nature, and his sterling straightforward character. The President was only in office for one year, and then had little or no further responsibility. The Secretary, however, was more or less permanent; and it was on him that most of the anxiety and labour devolved. Mr. Whimster had the interest of the Association at heart, and had done much for it. It therefore gave him very great pleasure to make the presentation to Mr. Whimster, on behalf of the Association [handing over a purse of sovereigns]; and he felt sure the members would all endorse his words when he expressed the hope that he and Mrs. Whimster would enjoy good health for

many years to come, and that he would long continue to give the Association the benefit of his valuable assistance as Secretary and Treasurer.

Mr. WHIMSTER, in acknowledging the gift, said that when the Association was launched in 1887, it was purely an experiment. It was considered that such an organization was wanted; but in Ireland gas managers were so few and so widely scattered, that no one could foretell the result. The justification of the experiment was to be found in its success. Every meeting had been usually considered more successful than the former ones, and the present one had been no exception. The success had not depended on the number of prominent men, of large experience and having control of large works, but rather on the number of working managers, men who had to do the work, and grapple with the difficulties themselves, and who had met together and exchanged experiences—learning from one another how to meet the petty difficulties and worries of their every-day work. Of course, keeping abreast of the times, and studying the brilliant advances being made in the high places of the profession, had not been neglected by them. Thanks to Professors Macadam and Tichborne, who had so kindly placed their skill and learning at their disposal, they had usually had matter suited to all tastes. Apart from papers, however, he believed the Association had justified its existence by bringing men of the same profession—necessarily isolated—from all parts of Ireland, into touch with each other; and the annual re-union, the friendly hand-shake, and the congenial "shop" talk with an intelligently appreciative companion, were often as good and helpful as the more formal paper and discussion. He had sometimes thought that an informal meeting—beginning with a Chairman's address, followed by a free-and-easy conversation on any and every topic of interest to those present, and closing with a scientific lecture—would be a valuable deviation from the regular routine, and worth a trial. He wished particularly to thank the members most sincerely for their handsome expression of appreciation of his services as Secretary, which it would be pedantic to pretend to regard as given in any other than a friendly—even brotherly—spirit; for he seemed to know nearly every one so well, and to be on terms of the closest friendship with them all. But while he had gladly and cheerfully done what he could as Secretary during the past twelve years, he trusted the members would not think him ungrateful, when thanking them for their generous gift, if he said, in all seriousness, that he hoped they would really make an effort to relieve him, and ask some younger man to

take the position, as he felt that the duties and responsibility were getting too much for him in addition to his other work.

Votes of Thanks.

Mr. Tully moved a vote of thanks to the Corporation of Dublin, and to Mr. Thos. J. Cotton, the Inspector of Lighting for the City, for the use of the City Hall.

Mr. Cotton acknowledged the vote.

The Hon. Secretary moved, and Mr. Langlands seconded, that the Association record their appreciation of the very able and valuable services of their worthy President.

The President returned thanks, and the meeting concluded.

During the midday adjournment, the members paid a visit to the brewery of Messrs. Guinness, Son, and Co., where they were shown over the establishment, and were hospitably treated.

In the evening, the Association were entertained to dinner in the Gresham Hotel, Sackville Street, by Mr. C. S. Spear, of Dublin. Mr. Spear presided over a company numbering about fifty. After dinner an enjoyable smoking concert was held.

The following day, an excursion took place to Bray and the vicinity, in brilliant sunshine. The party travelled by rail to Bray Station on the Wexford Railway. Thence they proceeded in coaches by the rocky glen to the Powerscourt Waterfall, one of the prettiest in the United Kingdom. On the return journey, they drove through the Powerscourt Demesne, the natural and artistic features of which were much admired. After dinner, in Miller's Leicester Arms, at Enniskerry, the company walked down the Dargle Glen—a scene of great grandeur—and, reaching Bray about five o'clock, took tea in the International Hotel. There was then time for a stroll upon the esplanade, which terminated probably the best outing the Association had ever had.

MANCHESTER INSTITUTION.

QUARTERLY MEETING, SEPT. 9.

The One Hundred and Nineteenth Quarterly Meeting of this Institution was held at Blackpool, under the presidency of Mr. R. G. SHADBOLT, of Grantham.

VISIT TO THE GAS-WORKS.

The proceedings opened with a visit to the Corporation gas-works, which the Chairman and members of the Gas Committee had kindly thrown open for inspection. Mr. John Chew, the Gas Engineer to the Corporation, conducted the members over the establishment, and explained the various points of interest and novelty. They found that the works had been considerably extended, and that the whole of the available space in the retort-house was occupied; the total number of retorts being 372—all of the horizontal type, with regenerator furnaces. The foundations had been put in for a new washer-scrubber, which was being erected by Messrs. Kirkham, Hulett, and Chandler. The purifying plant had been considerably enlarged; the number of lime purifiers having been increased to three, each measuring 45 feet by 25 feet. During the visit, great interest was taken in the Pelouze and Audouin condenser, made by Messrs. R. & J. Dempster, Limited, which was erected a few years back; while another noteworthy addition to the plant was a new enricher for improving the quality of the gas by benzol or light oils. This was put up by West's Gas Improvement Company, Limited; and many comments were made on its handiness and utility, particularly by managers of small works, who thought it was specially adapted to such cases as theirs. In the sulphate works, a new superheater by Messrs. R. & J. Dempster had been set in operation on the day of the visit. The visitors witnessed a novel method devised by Mr. Chew for disposing of the "devil" water, which was re-pumped into the still; the sulphuretted hydrogen being sent forward to the purifiers, and recovered in the oxide as sulphur. A most important part of the extensions,

however, was the new gasholder, in three lifts, each 150 feet by 32 feet, erected by Messrs. Clayton, Son, and Co., having a capacity of 1½ million cubic feet, the tank for which was constructed by Messrs. Dent and Son, of Nelson. The Corporation have acquired six acres of land on which are to be erected new works which will include a new reserve water-gas plant of about 500,000 cubic feet capacity per day, and railway sidings sufficient for both works.

At the close of the visit, the members proceeded to the Palatine Hotel, where luncheon was served. After luncheon,

Mr. WILLIAM CARR (Stalybridge) moved a hearty vote of thanks to the Corporation of Blackpool, for their invitation to the members to inspect the gas-works, and for the very cordial reception that had been given them. He thought it was a very admirable thing on the part of corporations who owned gas-works that they should encourage gatherings of this kind, for the interchange of ideas and opinions, not only that those participating therein might meet each other, but that by visiting the various works they might pick up hints as to what to adopt and what to avoid in their own places. All corporations were not like that of Blackpool; but generally he found that, where they had a good Gas Engineer, they had also a good Gas Committee. He (Mr. Carr) was quite sure that the Corporation of Blackpool were very fortunate in the selection of their Gas Engineer, and still more so in having been able to retain his services for a period of something like thirty years. Blackpool had a very special interest for him (the speaker), as a gas engineer; and he thought all people connected with gas, either as makers or as shareholders in gas companies, ought to view it in the same light. He remembered going to Paris in 1878, when the gas industry was threatened with extinction by a new electrical illuminant that was going to perform marvellous things. It certainly created a great stir, and caused the price of gas to be considerably reduced in this country in a short time; but that illuminant had passed away, and gas was still going on. Not much later, he went to Blackpool, and saw what was probably the earliest electric lighting installation in the North of England. He did not think the Blackpool Corporation were governed by economical motives in putting in the electric light. They had been very enterprising and progressive, but more with an idea of making the place attractive to visitors than with a view of saving the ratepayers' money; and if anything great could be done with the electric light, it had been done in Blackpool. If it had been at all possible to extinguish the gas industry anywhere, there

ought to be no gas made in Blackpool that day. But what was the actual state of affairs? They had just seen, in going through the gas-works, new buildings put up here and there, and likewise a new gasholder—the largest they had ever erected, and one which a few years back would never have been dreamed of in the town. Mr. Chew had informed him that he came to Blackpool when the output of gas was only 15 millions, and now it was over 400 millions, with an increase during the last six months of about 20 millions. It was a large increase, and was obtained in the face of an opposition which had been pushed regardless of financial considerations. This was a great tribute to the utility of gas, and ought to give encouragement to them all as showing what gas could do, and how it could hold its own against the strongest opposition from the electric light.

Mr. ROBERT PORTER (Elland) seconded the motion; and in doing so observed that he looked back with pride to having received his first introduction to the gas world at the Blackpool works, under Mr. Chew.

Mr. BATTERSBY, the Chairman of the Gas Committee, briefly responded.

Mr. CHEW remarked that in Blackpool they were not afraid of the electric light, and never would be. If they put the same energy into gas making as they had done during the past twenty years, they would have nothing to fear. Of course, corporate bodies were inclined to promote the favoured child—that was the last born—which was the electric light; and, as they all knew, the elder son was sometimes heavily taxed to support the younger members of the family. He might say that their capital was about £140,000; and the Corporation had spent some £120,000 or £130,000 on the "younger child." His advice to gas people was: "Cut your capital down as much as you can. We have to compete with this younger child, which is favoured at every point." They must face the position like men belonging to the gas world, who had had long practical experience. They must not sit down quietly, and think they knew everything—that everything was in their favour, and that their custom was ready made for them whether they stirred themselves or not. Let them rouse themselves, and put gas in the forefront for lighting, heating, and cooking. There would then be a great future for it.

Mr. FLETCHER, referring to the great controversy which had been going on as to the best plan for doing away with smoke from chimneys, said that this problem was being solved in Blackpool. Very nearly all the cooking in the town was done, during

the summer time, by gas apparatus; and had it not been for these cookers, they would have had a different atmosphere than they had that day.

The Business Meeting.

After lunch the business meeting was held—Mr. Shadbolt presiding.

New Members.

The minutes of the previous meeting having been read and confirmed, the following gentlemen were, on the motion of Mr. W. Duff (Morecambe), seconded by Mr. R. Porter (Elland), elected members of the Institution: Mr. T. Davies, Llandudno; Mr. A. F. Goodson, Heckmondwike; Mr. J. Lee, Carnforth; Mr. E. Shaul, Penrith.

Mr. W. Whatmough (Heywood) then read the following paper:—

NOTES ON THE WORKING OF A SELF-LOADING GOVERNOR.

The question of the automatic regulation of gas pressure has in recent years been frequently discussed at the various meetings of Gas Associations; but as the principles involved have been based upon the regulation of pressure at the point of supply, I thought it might be of interest to the members of the Institution to give the results of the practical working of the self-loading governor in use at the Heywood Gas-Works. The district of supply is a scattered one, with about 40 miles of mains; the works being situated at the lowest level, with the exception of a small portion of the district about two miles away, which has a special main and governor. The remainder of the gas supply (or 98½ per cent. of the whole) is passed through what is termed the town governor.

It was in the autumn of 1893, in consequence of the town governor being old and unsatisfactory, that my Committee decided to fix a new one with 21-inch connections, in order to provide for future demands; the trunk mains being 18 inches in diameter. The new governor is one of the latest designs of Messrs. Braddock, arranged with two valves balancing each other, and acting in opposite directions in combination with the bell of the governor, and which is also well adapted for the attachment of the automatic pressure-changer made by the same firm. After the governor had worked successfully for about six months, the question of automatic regulation of pressure was taken into consideration; and although the principle of self-

loading governors had not been very favourably received, yet the apparatus was so simple, and in the experimental stage so effective, that a trial on a practical scale was decided upon. The

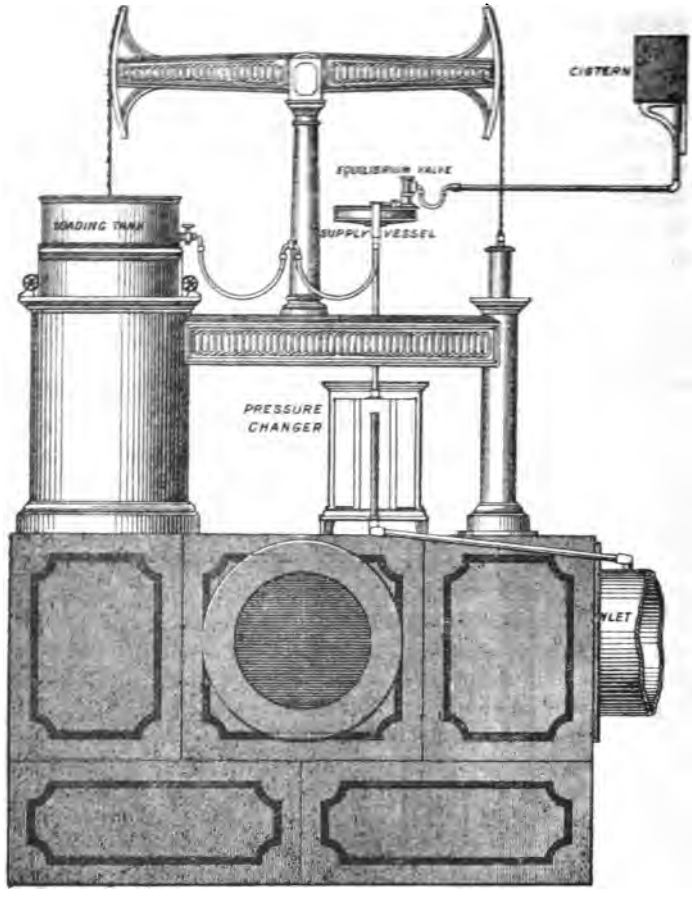


FIG. 7.—SELF-LOADING GOVERNOR AT THE HEYWOOD GAS-WORKS.

apparatus was fixed and completed in February, 1894; but before fixing it, however, the portable pressure-register was placed at various levels in the district, in order to ascertain the minimum and maximum pressures required to give a satisfactory supply.

These were found to be 8-10ths and 20-10ths respectively; and the governor was regulated accordingly.

The arrangement is designed to give automatically an increased and diminished outlet pressure as required, although the inlet pressure may vary. The drawing shows the arrangement as applied to our station governor. It consists of a loading-tank charged with water, fixed on the bell of the governor, the supply of which varies automatically according to the demand for the supply of gas. In order to compensate for the varying inlet pressure, a bell and float are fixed, which work in a small tank, and vary in height (according to the inlet pressure) by means of a small pipe connected to the inlet-main.

On the top of the bell and float is a small vessel supplied with water, controlled by an equilibrium valve which regulates the water for the loading-tank, and is connected by a flexible tube, so that the level of the water is the same in both the vessel and the loading-tank. The vessel also has an overflow to carry off the surplus water when the demand for gas decreases. There is provided a cistern for the water supply, which is controlled by a ball tap; and the pipe from the cistern is connected to the equilibrium valve referred to.

The pressure-changer is very simple in its operations. Immediately the bell of the governor falls, the equilibrium valve which controls the supply of water responds to the call, and the additional pressure required is given. When the governor-bell rises, the converse takes place, and water is thrown off the tank, and the pressure reduced. As we have a plentiful supply, the water is allowed to run to waste; but if required, arrangements could be made to use it over again. The quantity needed, however, is only small—being about 2 gallons for the largest opening of the bell when putting on the pressure from the minimum to the maximum.

In the working of the governor, however, and when loaded to give the maximum outlet pressure, the bell has a tendency to rise and partially close the valve when the inlet pressure increases, which would cause some of the water to be thrown off the loading-tank and reduce the outlet pressure. This is obviated by the bell and float, which are subjected to the inlet pressure, rising to the same extent as the governor bell, and maintaining the level of water in the loading-tank, and consequently the maximum pressure also. The governor may be loaded by weights or water in the ordinary way if required, by closing the water-supply tap attached to the loading-tank and connected to the flexible tube.

From the foregoing description, it will be observed that the apparatus is free from complex mechanism, and that simplicity is the charm of the arrangement, for there is practically nothing to get out of order, and at any time all the parts are easy of adjustment. In the case of the maximum pressure, it is only necessary to regulate the overflow of the loading-tank to obtain what is required; and to change the point of loading, the raising or lowering of the water-supply vessel is sufficient.

It was with diffidence that we entered upon our first trial, as the dark days were still with us; but it was arranged, for safety, to experiment only during the day, unless the child of adoption should prove "wiser than the children of light," and put on the pressure before the usual time. We were not disappointed; the changer answering to the call a considerable time before the pressure would have been put on by the attendant.

Diagram No. 1 shows the old and new system of loading; the dotted line denoting the loading by hand, and the full line by the automatic regulator. The diagram no doubt will be considered a good one; yet it will be observed that, although the governor commenced loading before the time appointed by hand, it was rather slow at taking on the pressure—due in a measure to the size of the governor being in excess of our requirements, which

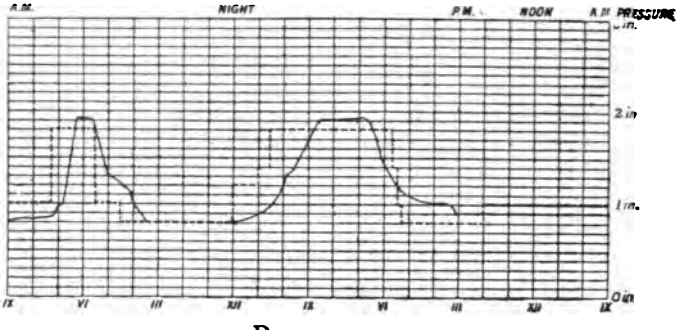


DIAGRAM 1.

prevented the rise and fall of the bell which was desirable for satisfactory working. In these circumstances, it was decided to reduce the capacity of the valves to the capacity of the trunk mains, and at the same time to increase both the minimum and maximum pressures to 11-10ths and 25-10ths respectively. When this was done, the apparatus responded to the variation of supply more quickly.

Diagram No. 2 shows the changer at work on an ordinary winter's day, which is everything to be desired. There is no

delay in the putting on of the pressure, and the maximum is fully maintained until 10.30 p.m., when the pressure is gradually

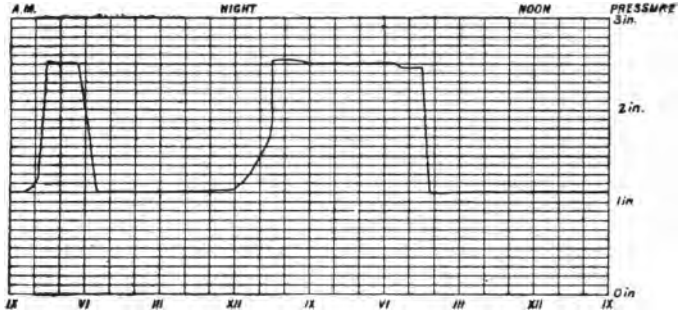


DIAGRAM 2.

reduced to the minimum, until 5.30 the following morning—the mills and workshops again asking for a maximum supply, which is given in a satisfactory manner.

Diagram No. 3 is for Sunday, and shows an increase of pressure from 11.30 a.m. to 12.30 p.m. due to the large demand for cooking purposes on that day. Although we have upwards of 40 gas-engines and other apparatus working throughout the week, our maximum day pressure does not equal the pressure required on Sunday morning. This no doubt is attributable to the fact that

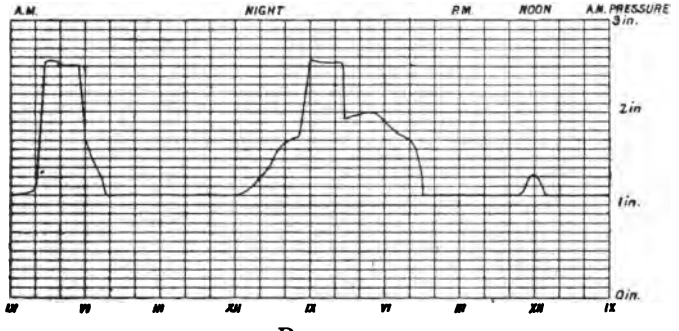


DIAGRAM 3.

the mill operatives invariably have the best meal of the week on that day, and practically all the gas-stoves are in work at the same time—the number of stoves and grillers in use being 2422. This is equal to 53·66 per cent. of the total number of consumers; so that rather more than every second consumer has either a cooking-stove or a griller. Still following Diagram No. 3, the

pressure does not arrive at the maximum until about 8 o'clock, which is the hour of closing the various places of worship. This

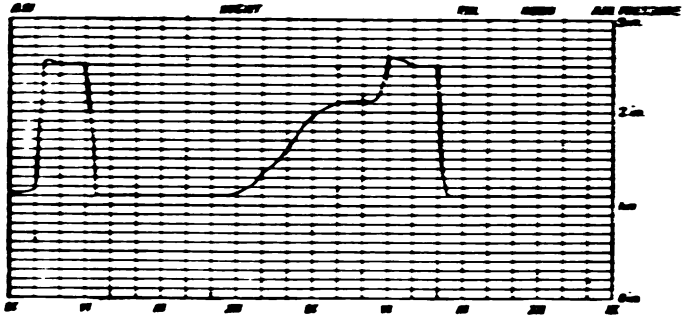


DIAGRAM 4.

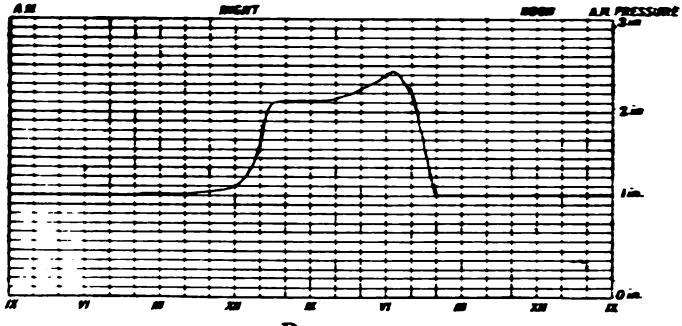


DIAGRAM 5.

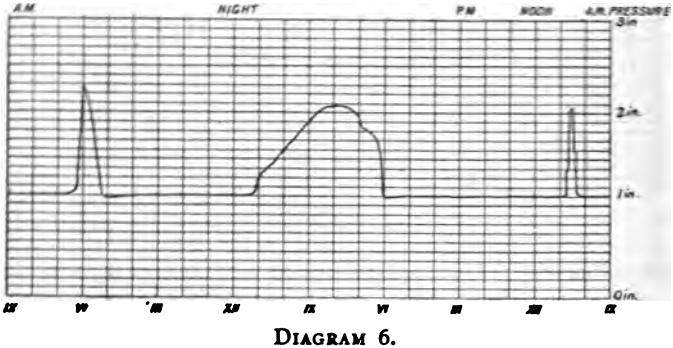


DIAGRAM 6.

would appear to indicate that further enlightenment is required after the people return home from their spiritual devotions. The

difference in the time the maximum is maintained is most marked compared with Diagram No. 2.

Diagram No. 4 shows the action of the changer on Tuesday evening—being the tradesmen's half-holiday. At six o'clock (after the mills and workshops are closed), there is a reduction of 4-10ths pressure, and afterwards a gradual decline until the minimum is again reached. Diagram No. 5, which is for Saturday, also shows a diminution of maximum pressure, due to the mills and workshops closing at noon on that day. The pressure for early Sunday morning, it will be observed, is at the minimum, and shows the contrast between the morning pressure given on the other days of the week. This is a true indication that the people are resting from their labours. Diagram No. 6 shows the effect when sudden darkness appears, which in this case was between 10 and 11 in the morning; and the great advantage of the apparatus will at once be conceded under such circumstances.

I have selected the foregoing diagrams so that it will be seen how the demand varies in the ordinary working of a gas-works, and for special purposes also.

One of the most important factors in deciding upon the changer was the question of leakage; for there was every indication that it would be reduced. But as in the winter months the pressure was invariably put on earlier than it would have been by the attendant, there were certain misgivings on this point. The following statement from our published returns, however, gives the leakage as follows:—

1894	10·42 per cent.
1895	10·35 ,,
1896	8·54 ,,
1897	7·17 ,,
1898	6·86 ,,
1899	6·52 ,,

This statement shows a reduction in leakage of 3·9 per cent. during the period under consideration, equal to a saving of 4,627,000 cubic feet per annum on the gas manufactured at the present time. The result, therefore, shows that there need be no anxiety as regards increased leakage, but rather an assurance that the consumer obtains his supply of gas when he requires it, instead of waiting patiently for his illumination at the hands of the fickle attendant. I do not, however, claim that the above saving in leakage is entirely due to the adoption of the changer, as our sales of gas have increased considerably; but at the same time there has not been any extraordinary expenditure in reduction of leakage. I am fully aware that even now the

leakage is considerably in excess of many towns; but, as already pointed out, the mileage of mains is large in proportion to the consumption.

It is important to bear in mind that there can be no satisfactory working where the mains are connected to other districts supplied by separate governors at different pressures. There must be complete isolation from the other districts of supply, or it is impossible for the apparatus to work satisfactorily. As previously explained, we have two governors; and the changer is only fixed to the town governor. But the two districts are merely separated by the insertion of a valve; and when this is open, the changer ceases to act, because the pressure in the other governor is always higher than the town governor.

It may be contended, however, that the governor ought not to be the medium for putting on its own pressure, and that circumstances may arise when, owing to distance and friction in the mains, the demands of the consumers will not meet with the response which is desired. I can only say that in practical working we have not experienced this difficulty. This is due no doubt in a large measure to our governor being placed at the lowest level in the district of supply, and the sudden rise of 30 feet in level from the works, which causes the governor to be much more sensitive than would be the case if fixed at a higher level. It may also be contended that, with self-loading, pressure will be given when volume only is required. For instance, supposing the valve has opened to a point at which self-loading begins, increased pressure may be given instead of increased volume. Following up the same principle, the effect would be, in loading the governor, that until the maximum pressure was attained there would be an excess of pressure instead of increased volume. This may be right in theory; but under our present system of supply, and so long as the carrying capacity of the mains is so inadequate to meet the demands without extra pressure, the principle does not apply in general working. With the self-loading governor, any demand in excess of the minimum pressure may be taken as an indication that the mains require pressure, and not volume, in order to obtain a satisfactory supply. But even if an excess of pressure be given, the only question affected would be the leakage; and the published returns already given are sufficient to assure the most sceptical on this point.

Of course, it is common knowledge that the self-loader has by some been considered an unreliable instrument; that the principles of working are wrong; and that the requirements of a

district cannot be supplied in a satisfactory manner by the system. But the old adage is still true, that an "ounce of practice is worth a pound of theory." The practical satisfactory working of the self-loader during the past five years, is sufficient proof that under our conditions of working we could not do better; and in these circumstances, I am of opinion that the governor is the most satisfactory point for the controlling of pressure.

The advantages of the self-loading automatic pressure-changer may be summarized as follows:—

1.—It is thoroughly under control at the works.

2.—It is simple in its action—requiring no attention, and no cost to work it.

3.—The capital outlay is very small.

4.—The satisfactory working for five years has proved its utility.

In conclusion, I can only again call your attention to the diagrams to show you the great advantage of the automatic pressure-changer compared with hand loading, which we know, when carefully done, assures a fairly satisfactory supply. But the impossibility of deciding beforehand the time at which to load by hand, the variation in consumption at different periods of the year, and this changeable climate of ours, render the automatic pressure-changer a desirable instrument to be adopted in the distribution of gas supply; and I feel persuaded, from the advantages enumerated, that the system will commend itself to the members of the Institution.

Discussion.

The PRESIDENT having invited discussion,

Mr. PORTER said he had had some experience with a pressure-changer, but not in connection with a governor like the one described. Some four years ago, he attempted to regulate the pressure as explained by Mr. Whatmough, on an existing 24-inch governor by Braddock; but he had to abandon it. He must point out that the governor was not made with the view of attaching a pressure-changer to it; and perhaps this had a good deal to do with the failure. What were the advantages to be claimed for this pressure-changer? In the first place, he very much questioned the desirability of having a governor at all. He thought the subject of high *versus* low pressure gas supply had been brought up by the paper; and he must say, from the experience he had recently had, that he very much favoured the former. This would, no doubt, come rather as a surprise to many members; but he believed he had a justification

for it in the paper. Mr. Whatmough said they had reduced the leakage; and he practically told them that, though this pressure-changer had put on the pressure much earlier than previously, when it was put on by an attendant, and the consumers had a higher pressure at their fittings during the 24 hours than they had hitherto had, the leakage was reduced. He (Mr. Porter) had had experience in connection with a company who had a minimum pressure of 26-10ths and a maximum of 42-10ths; and though the company, turning out about 60 millions per annum, had worked under this high pressure, and given the consumers every satisfaction—as the gas had always been available at such a pressure that it could be used for any purpose all the 24 hours—their leakage was only about 8 per cent. Another company, sending out about 65 millions, had never less pressure on the mains than 36-10ths; and their leakage was under 10 per cent. Now there was no doubt there must be a slight increase in the gas lost by leakage; but the advantages gained by the reduced size of mains, which overcame the difficulty of the consumers' fittings being too small, must outweigh the drawback involved in the extra loss of gas. Therefore he did not think the advantages claimed for the pressure-changer were all that could be desired.

Mr. CHEW said he had for many years had an arrangement of the kind described; but perhaps the fact that he had not isolated the governor would have something to do with the results obtained, which were not such as had been given in the paper. The more important question, however, seemed to be that of high and low pressure. He had perhaps as little leakage as most people. It was not a hilly district—the greatest variation amounting to 30, 40, or 50 feet; but at the same time he believed a good pressure—that was to say, delivered to the consumer at not less than 15-10ths—would never cause a great increase of leakage. After midnight, when the consumption was very small, he dropped to 10-10ths; but afterwards it was never less than 15-10ths to 18-10ths during the day. He was inclined to think that he would do even better if he gave more, inasmuch as by an increase of pressure the detection of leakage was rendered a much more easy matter; the gas coming to the top much sooner. He had found this to be the case from long experience. During the last ten years, he had not had more than 3 per cent. of gas unaccounted for; and in the same period he had never had a lower pressure than 10-10ths during the small hours of the morning, and in the daytime 15-10ths to 25-10ths. Under these circumstances, although he did not agree with Mr. Porter that

they should give enormous pressure, which would mean great waste in the consumption of gas at the burner on the part of the consumer, he thought they might give a reasonable amount of pressure, whether by some automatic arrangement or otherwise. He had tried one of the earliest types of automatic changers—the members had seen the governor that day. He had found that with these automatic regulators they really wanted a man to sit beside them to keep them right; and when the dark days came, he found he could not rely on the apparatus to give the required pressure. He was not disposed to go back to the method described. Again, he might say that a reasonable amount of pressure did not increase the leakage, if they paid careful attention to the meters, service-pipes, &c. They must keep the meters in proper order, and renew the service-pipes when necessary. He had adopted the plan of using lead pipes and covering them with tin to prevent the honeycombing which sometimes took place. They must protect the gas mains and pipes from the action of the electric current escaping through the ground. Certain pipes belonging to the Water Company had been very severely honeycombed, which caused the water to escape freely. What took place in the water-pipes, would have to be guarded against in the gas-pipes. The difficulty in this direction was increased tenfold when they had electric mains all over the place. He had had practical experience of the effects of the escape of electricity on the pipes.

Mr. R. SHADBOLT (Fleetwood) said they had used the self-loading governor for somewhere about eighteen months at his works; and his experience was that it was a far superior governor to the hand-loading one. It was a very convenient arrangement. When he left Fleetwood that day, for instance, he had locked the place up, and ordered that no one should go in. The governor would automatically put the pressure on just when it was required, but not before. It was the same in taking the pressure off at night. As soon as gas was not wanted, and the consumption stopped, the pressure was taken off. By looking at the diagram, they would see how faithfully it acted. He could quite understand circumstances arising, as in the cases mentioned by Mr. Chew and Mr. Porter, where the governor would be prevented from acting properly; but it was not fair to condemn the governor on this account. Owing to Mr. Porter adopting the system, he himself had been led to introduce it at Fleetwood; and he thought it was a most excellent apparatus. As to leakage, he could not say a great deal; but he did not suppose they lost much less gas than formerly—perhaps about

1 per cent. represented the difference. He, however, knew that they had, at any rate, a little more gas accounted for, and he considered this to be due to the action of the self-loader. Of the quantity of gas made, they had a little more—about 2 per cent.—sold. The self-loading governor was a step in the right direction; and with it they never experienced trouble through the man forgetting to turn the pressure off, as was often the case under the old arrangement.

Mr. A. GRAHAM (Mansfield) said that when at Hebden Bridge the two holders were 1½ miles each side of the works. The surplus gas used to go to the holders, from which it was taken back to the town, when enough gas was not being made at the works. The leakage, even under these conditions, was never above 10 per cent. Twelve months ago, he was considering the question dealt with in the paper, and would have adopted the same system as that used by Mr. Whatmough; but, on inquiring into the matter, he found the mains must not be connected in the town. He therefore adopted two governors, on two 12-inch mains, but without the automatic water supply; and he was satisfied in every respect with the working. The water was turned on by a tap about an hour before the pressure was required, and turned off by the same means.

Mr. C. A. CRAVEN (Dewsbury) said he had had five or six years' experience with a pressure-changer, and had no trouble with it. They had not a tenth part of the bother about the pressure that they previously experienced. The district was essentially a factory one; and at times it was not advisable to put the full pressure on. At such periods, they had just allowed the governor to put the pressure on to a certain point, as required. Then, again, if any repairs to the governor or loading apparatus were necessary, it was easy to temporarily revert to the old method. The men liked the system very much. In their works they had the loading apparatus and the concentric tank, and had three divisions in it. They made their day pressure 9-10ths, which gave about 14-10ths in the lower part of the town; and they could make the maximum 18-10ths, or change it to 20-10ths, or, in the third chamber, to 23-10ths. He could corroborate Mr. Whatmough's summary of its advantages.

The PRESIDENT said the author might with advantage have given not only the pressure at the works, but also in the heart of the district. It would have helped the members to arrive at a right conclusion on the subject.

Mr. WHATMOUGH said very few people would agree with Mr. Porter that governors should be dispensed with. He thought

the reason for the failure Mr. Porter had referred to in connection with the automatic changer was that his governor had such a large area, and was of an old-fashioned type, with the result that a great weight would be required, and loading would be very slow indeed, and consequently unsatisfactory. Mr. Porter seemed to think the advantages he had obtained were due to the circumstance that they worked at high pressure. As a matter of fact, the pressure was practically the same as before, except that it was put on a little earlier than by hand. The reason for Mr. Chew's governor failing was no doubt want of isolation. They must have it isolated, or it was of no use whatever. Mr. Chew said it was connected in other parts of the town; consequently the changer was thrown out of action, and could not possibly work. He also understood that Mr. Chew had had a man to put the pressure on. It appeared that he required special pressure at special times; and if this was so, of course the automatic regulation would be thrown out of action, even supposing there was complete isolation. He welcomed Mr. Shadbolt's testimony. Mr. Graham simply referred to the ordinary governor; he did not touch upon the question of the changer at all. There was no doubt the apparatus was very easy of adjustment. As to diagrams taken in the heart of the district, he did not quite follow the President's suggestion. Before they adopted the pressure-changer, their supply was satisfactory in the lowest parts of the town; and they only worked on the same principle now—the supply being given as it was wanted. He did not think a diagram taken in the district would have helped the members in the least. In conclusion, he might again say that he did not think they could do better than adopt the pressure-changer.

The PRESIDENT observed that Mr. Whatmough had scarcely understood his suggestion. Their practice was to put a portable register down in certain parts of the district, and see whether the pressure reached the point required.

Mr. W. CHEW then contributed the following paper :—

GAS TRACTION ON THE BLACKPOOL, LYTHAM, AND ST. ANNE'S TRAMS.

The desirability of using gas-engines as a means of driving tram-cars having in recent years attracted a good deal of attention from engineers generally, it has been thought a fitting opportunity for the members of the Institution to familiarize themselves with its application as in use at Blackpool.

The propulsion of gas tram-cars having been in daily use here since July, 1896,* it is now lifted out of the experimental stage, due to its initiation, to that of general utility; and its capabilities can now be measured by actual working results. You, as gas engineers, are directly interested in its success, from two main causes—one is that, in the event of their extensive application, there is the prospect of a large demand for gas wherever installed; and the other (perhaps of still more importance) is the certainty that there will be total freedom from the evils of electrolysis to your mains if gas-trams are adopted in lieu of the electric trolly system, as now being erected in this country, the ravages from which are so well known in the United States, and even in this locality. It is with this twofold knowledge before you, that you are asked as gas engineers to examine the working details of the system which, if applied, is likely to be so beneficial to the industry, and at the same time relieve your anxiety with regard to the evils attending electrolysis of pipes on tram routes.

Without going into the history of the formation of the Company, but taking it as it exists to-day, we find the line connects the three towns along the high-road, by 7½ miles of single track, 4 ft. 8½ in. gauge, with loops where desired. The route is fairly level throughout, with the exception of the high railway bridges, which are crossed with a gradient of 1 in 25. There are in daily use fourteen cars, making 75 to 100 mile runs per day, as need be—more in the season, and less in the winter months. The total mileage this year will be 200,000 car-miles, as against 260,000 car-miles run by the Blackpool Corporation electric trams. This, I think, will give you some conception of the magnitude of the Company's operations.

Turning to the station and appliances, we find a car-shed, with cleaning pits, and a fine airy building of neat design, having suitable offices, workshops, stores, and compressing-rooms adjoining. The compressors occupy little space; each one being strap driven by 4-horse power (nominal) gas-engines. These take the gas direct from the town supply into the receivers, which are fine specimens of welded cylinders, and store the gas for use at 200 lbs. pressure per inch. All gas used is measured and checked to the engines, and for other uses, by separate meters belonging to the Company. The repairing shop contains all tools for such needy repairs as occur from time to time.

This, then, constitutes the whole of the apparatus (with the

* See *Journal of Gas Lighting*, Vol. LXVIII., p. 68.

exception of a sub-station at the Lytham end, for charging purposes only), which is extremely simple throughout. The cars used are the double-decked type, mounted on four wheels, carrying 52 passengers inside and out, well upholstered inside, and in appearance outside equal to the best tram-cars of other makes. They are *minus* the fishing-rod appliance used on electric-trolly lines; while the absence in the streets of poles and wires is a decided improvement. The gas for the motive power is stored in three steel tubes under the carriage body, while the engine is snugly housed along one side—the working parts being easily accessible from the roadside. For cooling the engine, a condensing coil is placed on top, between the double deck. The engine is 15 brake horse power; and the feed is regulated to a constant quantity for the varying pressure of gas.

The stopping and starting is actuated from either end by the driver. There are at present only two motions arranged for—the one, called fast, being set to the limits of the Board of Trade regulations; and the other, called slow, for climbing the ascents before named. This prevents reckless driving, and is safer for the public. But there are times when, with a clear road, a higher speed might be used with advantage, as is done on the local electric trolly lines. This matter, I understand, will be remedied should gas traction be applied to light railways hereafter, as the public idea of success is measured only by speed attained.

Following a car from the depôt on its daily routine, it first takes up its charge of gas at about 140 lbs. pressure, which is sufficient for a run of 15 miles. Then, taking its position at the Blackpool end, it loads up with passengers and continues its journey to Lytham, picking up *en route*. Arriving there, it reloads and, passing the sub-station, either calls or passes on as needs be back to Blackpool. On passing the depôt, it replaces the quantity of gas used; the time occupied being 1¼ minutes only. And so on throughout the day. I must here say that a hose-pipe is connected with a main from the receiver, and is easily accessible to the driver in the centre of the track. He quickly opens the box-lid, couples the india-rubber tube (similar to a water-hose), turns the cock, and in the time named the car is off again. The engine is stopped only at each terminus; but for small stops on the way it is run continuously at light load. The effect of this is to give a not altogether unpleasant longitudinal oscillation to the cars, owing to their small wheel-base. Whether or not it is advisable to alter this movement is an open question. The condensation of the waste exhaust—always a difficult matter—is well overcome in the newer pattern cars; these being larger

and more airy throughout, while the earlier types are smaller and a little deficient in power in this respect.

Turning to the financial side of the Company, the nominal capital is £125,000. The Company having been re-formed nearly a year ago, and not having yet issued their first balance-sheet, it would be presuming too much were I to anticipate their dividend for the first year; but the working statistics of all tram companies are based on the working expenses per car-mile, and if figures supplied by the Manager can be continued, these will compare favourably with those of the electric trolly lines.

The result of two systems with similar mileage is given in the Technical Press for the undernamed towns as follows, for working expenses per car-mile:—

Dover	7·00d. (trolly).
Blackpool	10·30 (conduit).
Gas-trams	5·16

The 5·16d. is the price at which the Tramway Company have contracted with the Gas Traction Syndicate to work their line, covering all working costs. Judged by this basis, gas traction holds a fair position. But as the figures may not all cover the same ground, I have adopted one referring to cost of power only. I find the electric trolly used ¾ to 1 unit per car-mile; and this is valued at different rates, according to whether the Company generate their own current or the electric-light depôt sell the current to them at a profit per unit. Taking two companies of about similar mileage, the cost is—

Dover	3d. per car mile.
Blackpool	1¾ „ „
Gas-trams	1 „ „

Placed in this form, gas again holds its own, though if cost price for each was charged, a further modification might be necessary.

In concluding my paper, I wish to thank the Tram Manager (Mr. Lewis Slattery) for his kindness in affording me any information required. From the preceding figures, it seems probable that the system may extend. If you can make it possible to get your various Boards to interest themselves in forwarding gas traction with only a fraction of the energy thrown into this class of work by Electric Light Committees desirous of finding a profitable output for their respective works, then I think I shall have accomplished the object of this paper.

There was no discussion on the paper.

Visit to the Gas-Compressing Station of the Tramway Company.

The members next paid a visit to the gas-compressing station of the Blackpool, Lytham, and St. Anne's Tramway Company, where they were received by Mr. Lewis Slattery, the Company's Manager, and Mr. Codlin, the representative of the British Gas Traction Company. The following particulars, in addition to those contained in Mr. Chew's paper, were furnished: The rolling-stock of the Company consists of sixteen motor cars, four of them being 40-passenger cars, and twelve (of a newer type, with many improvements) to hold 52 passengers. The Company have this year carried with the same rolling-stock 220,000 passengers more than last year. Several improvements have been made to the line, parts of which have been doubled; the distance traversed being about seven miles. But the Company have power to extend the line at the Lytham end. At the compressing station, the gas from the Corporation supply comes through a main meter; and the portion to be compressed passes to two compressors driven by a Crossley engine—a spare engine being also provided. Subsidiary meters record the quantity of gas used by the compressors and gas-engine; separate meters for each being fixed. After compression, the gas is forced into the holders, and taken thence through a pipe to the cars in the centre of the passing-place, where the cars are charged.

After the inspection, the party returned to the Palatine Hotel, where tea was served. Before the members separated, a vote of thanks was accorded to the Tramway Company for allowing them to visit the station.

WAVERLEY ASSOCIATION.

HALF-YEARLY MEETING, SEPT 14.

This Meeting was held in the Station Hotel, Melrose—Mr. W. B. M'Lusky, of Selkirk, the President, in the chair. There was a good attendance of members.

The Hon. Secretary *pro tem.* (Mr. A. C. Young, of Kelso) submitted the minutes of the previous half-yearly meeting, and they were adopted.

Next Year's Meetings.

A letter from Mr. J. C. Adamson (of Airdrie) was read, in which he suggested that next year—the century year—one of the meetings of the Association might be held in the good old town of Kelso, and in, if he remembered rightly, what was 38½ years ago called the Queen's Head Hotel, the cradle of the mother of Gas Managers' Associations—the good old Waverley.

Mr. D. Vass (Airdrie) thought that the end of the century had nothing very clear to do with the Association, and that they should not lose sight of the idea of meeting in the President's town. He moved that the next meeting be held in Selkirk.

Mr. J. M'Laren (Duns) seconded the proposal, and it was agreed to.

It was resolved to hold the September meeting in Dalkeith.

The President's Address.

The President then delivered the following address:—

Gentlemen,—What London is to the Incorporated Gas Institute, and Glasgow to the North British Association, Melrose may be said to be to this Association of country gas managers, which bears the immortal name "Waverley"—at once the most central and attractive part of the district from which we draw our members. I trust that we may have a most profitable and pleasant time in this ancient and historic place to-day. Our meetings may be likened to a family gathering. The hearty Scotch hand-shake, the homely chat, the free-and-easy, yet earnest, discussion of business matters, and the loyalty towards

each other which has ever characterized the members of this old Association, have all contributed to bring it successfully down through all those thirty-eight years of its existence, without either rules, regulations, or bye-laws of any kind.

Many of the old members have passed away since the last meeting here. The front rank has been reduced to the active "member for Jedburgh," and the retired "grand old man" of Haddington, the holder of the President's medal in the two oldest Gas Managers' Associations in the world, and one of the very few men now living who took an active part in the famous Flintoff gas controversy. Fresh troubles beset us. The fame of Border gas men, like that of Border divines, has been spread abroad in the land. It is not enough that we lose our old members—our young men are being "called." Even since we last met, two members have gone West in response to the call of promotion. We rejoice in their advancement, while we regret the loss our Association has sustained by their translation.

The record attendances which we have had at recent meetings is very gratifying. The growing desire on the part of gas managers in this district to meet with each other for the interchange of opinion is one of the healthiest signs of improvement. It is calculated to help, not only the individual member, but also the company he serves. A feature of our spring meetings in Edinburgh lately has been the visits paid to engineering works in the city; and our thanks are due to those firms of gas engineers who so kindly threw open their works for our benefit on those occasions.

I am called upon to-day to bring under your notice subject-matter calculated to provoke a profitable discussion; and it has occurred to me that there is no question which would be so valuable for this purpose as a review of the working details of small gas-works, such as we represent. I shall therefore confine my remarks to small things.

In days gone by, the work of the gas manager consisted chiefly in making and delivering gas to the consumer; the latter being left to make use of the commodity to the best of his limited knowledge of gas economy. To-day, if we are to hold our own in competition with the perfected mineral oil-lamp, and the more effective (if more expensive) illuminant, the electric light, we are bound, not only to supervise the fittings and burners of consumers, but must also fix suitable burners free of charge, in order to secure to our customers the greatest possible amount of light for their money. Further, we must popularize the use of gas, and employ every legitimate means in our power to have it

introduced for purposes other than lighting, so that, being fortified by a good going business, we may hold the field against all comers. The sphere of labour is greater to-day than it was in former times. In large undertakings, the work is distributed over many officials and workmen—every man to his particular branch; but in the small country gas-works, the whole work devolves upon one individual—the manager, who, to be successful, must zealously set himself the task of overtaking this extra work, and be untiring in his efforts to attain a measure, at least, of the success of the larger undertakings, in the management of which the best skill in the land, the most efficient apparatus and labour-saving appliances, and the smartest business methods are brought to bear. If the small works are to advance in the same ratio as the large, we must, while making the most of our present opportunities and working the plant which we have to the best advantage, carry out, year by year, as funds will permit, such improvements as will bring the works into line with modern practice; all new apparatus being set down from a complete plan of general improvement.

I have indicated that the manager of a small works is handicapped in the race. Let us inquire into ways and means of reducing this handicap. We shall consider, in order—

1.—Carbonizing.
2.—Coal: The selection of suitable coal for gas-making purposes, and the effect of the recent advance in prices.
3.—Temperature and purification.
4.—Unaccounted-for gas.

While it is now admitted that gaseous firing is the best system for medium-sized and large works, open firing predominates in small works; and its use is supported on the ground that, notwithstanding the waste of material and labour which it involves, as compared with regenerative firing, the ultimate cost of the gas per 1000 cubic feet into the holder, including wear and tear charges, is equal to that obtainable by the more scientific system, *plus* charges for interest, depreciation, and cost of renewals. With this opinion, I entirely disagree; knowing, as I do, the carbonizing returns under each of the systems of working in this district. And I may here point out that profits rise more rapidly under the regenerative system in this locality, where coal is high in price and coke correspondingly dear, than is the case in Central Scotland, where coal is comparatively cheap and coke a glut on the market. Let me make a comparison. One of the most serious drawbacks to good carbonizing results in

small works is intermittent working. As a rule, gas is made for twelve to eighteen hours per diem. Carbonizing is suspended, and fires are banked up during the night, with the result that in the morning the temperature of the oven is down, and hard firing is necessary for several hours before charging can be commenced. Some 7000 cubic feet per ton of coal is reckoned a fair average for the first "round." The consumption of fuel is abnormally high all day; and only towards evening, when "banking-up" time is again approaching, is a really satisfactory working heat obtained. The same set of circumstances is reproduced when, in very small works, the manager has to fill up the furnace with cold coke, reduce the damper openings, and leave the works for several hours on end to attend to main laying, meter surveying, or an urgent call to one or other of his manifold duties. With the regenerative system, on the other hand, absolute control over the air supply is obtained. Damper openings and primary and secondary air-passages may be reduced, and carbonizing suspended for several hours, without any appreciable loss of heat—and that with an extremely moderate consumption of fuel. The net saving over the year, with a make of 3 million cubic feet, is equivalent to 1000 cubic feet of gas per ton, *plus* the revenue from 25 additional tons of coke sold, or in all £88. This sum is sufficient to pay off the initial cost of the bench of retorts in two years, and thereafter to meet a reduction in the selling price of gas equal to 7½d. per 1000 cubic feet, not to speak of the saving in labour and the freedom from the anxiety and worry which are associated with the open fire, especially in small works.

Gas managers have been exercised more than usual this year with regard to coal supply, on account of the abnormal rise in price. Here, again, works equipped with a thorough recuperative system of heating retorts have occupied a strong position; for it is noticeable that the kind of coal which has advanced most in price belongs to that class which is indispensable for the production of coke suitable for the open fire. Nothing concerns the manager of a gas-works more than the selection of coke suitable for his furnaces. Coals producing excellent residual coke must, in many cases, be had, independently of the quality of gas which they yield; otherwise low heats or hard clinker will prevail. Such coals are good value for the money in the localities in which they are raised; but, coming into this district with 60 to 75 per cent. added for railway dues, they are unprofitable in the extreme. With gaseous firing, we find that a high temperature can be maintained in the ovens with a mixture of

coke containing an average of 10 per cent. of ash produced from cannels yielding a rich illuminating gas, and thus reducing the cost of enrichment. Upon such cannels the charge added for railway carriage amounts only to 33 per cent. of the prime cost. True, a certain amount of care must be exercised in the building up of a mixture of coals which will produce a coke containing an ash which will not hinder the free access of primary air to the producers with a moderate draught. The supply of this description of coal is plentiful; and wherever it can be employed, the illuminating power of the gas may be maintained, while the cost of production is reduced and the quality of the saleable coke improved. The following comparative statement of the relative values of several coals, based upon prices f.o.r. at Selkirk and working returns at the gas-works there, will serve to show that the cost of such coals per candle per 1000 cubic feet is less than that of those whose only claim to our attention is the excellent coke which they provide for our furnaces:—

Class of Coal.	Year.	Gross Cost of Coal per 1000 Cub. Ft. into the Holder.	Cost per Candle per 1000 Cub. Ft.	Ash per Cent. in Coke.
1.—First-class cannel, 32-candle power	1897	2s. 0·2d.	0·75d.	7
	1899	2 1·3	0·79	7
2.—Second-class cannel, 27-candle power	1897	1 7·2	0·70	7
	1899	2 0·4	0·90	7
3.—Second-class cannel, 27-candle power	1897	1 5·2	0·63	10
	1899	1 6·5	0·68	10
4.—Third-class cannel, 23-candle power	1897	1 5·6	0·76	5
	1899	1 8·8	0·90	5
5.—Whole seam coal, 21-candle power	1899	1 4·3	0·77	5

You will observe that during the past two years—

1st-class cannel	has advanced	at the rate of	1·1d.	per 1000 cubic	feet.
2nd	,,	,, (good coke)	5·2d.	,,	,,
2nd	,,	,, (inferior coke)	1·3d.	,,	,,
3rd	,,	,, (excellent coke)	3·2d.	,,	,,

Coals producing good coke have advanced most in price, whereas those yielding a large volume of rich gas have been least affected. This is doubtless due to the adoption, within recent years, of oil-gas enrichment and carburetted water-gas processes, and the increased consumption of steam coal consequent upon the prosperous state of the iron trade of the country. The effect has been to increase the demand for splint-coal parrot, and coals of the splint class generally, while reducing our requirements of the richer cannels. The result to the gas manufacturer is an advance from 0·76d. to 0·90d. per candle per 1000 cubic feet in the price of third-class cannel (taking prices

delivered at Selkirk), while that of first-class cannels stands at 0·79d. Such a revolution in values ought to impress upon us the importance of the law that the only safe guide to the purchase of coal is the value in sperm which the penny will bring. While the foregoing table was not intended to illustrate the effect of a judicious combination of coals in the way of securing the maximum amount of light at the minimum of cost, it will serve as an example in this direction. No. 4 is a 23-candle power coal, producing this quality at the rate of 1s. 8·8d. per 1000 cubic feet into the holder; the value being 0·90d. per candle per 1000 cubic feet. Nos. 1, 3, and 5, combined in equal proportions, produce 466 cubic feet more gas per ton, and give an average illuminating power of 27 candles; the cost per 1000 cubic feet into the holder being 1s. 8d., and the cost per candle per 1000 cubic feet 0·74d. I would repeat that this is merely an example, for the purpose of directing attention to the value of building up mixtures of coke for firing purposes.

I may add that I have, during the past eight years, employed mixtures similar to the above with generator and regenerator settings, always with satisfactory results, but particularly so with the full-depth regenerator. The enhanced illuminating value obtained by mixing several coals together in the same retort is appreciated all round; but the benefits attending the employment, in suitable producers, of coke high in ash, made from the richer cannels, which increase the illuminating power of the gas at a reduced cost for coal, have not been so widely recognized. In small towns particularly, where it is a difficult matter indeed to sell gas at a low price per 1000 cubic feet, the advantages of such a system as a means of at once increasing the illuminating power and durability of the gas, should not be lost sight of—especially as the consumer considers more the quarterly account than the technical price per 1000 cubic feet. And while we do aim at a low selling price, with the view to the more general adoption of gas for purposes other than lighting, we must bear in mind that, so long as the top candle is value for the money which the consumer pays, the policy of supplying rich gas is the right one, whether for lighting, cooking, heating, or motive-power purposes.

Let me now direct your attention to the advantages of maintaining the temperature of the gas at about 60° Fahr. in its passage from the foul main to the station meter. We have all observed how rapidly the illuminating power falls on a cold winter night, and at what a cost the required standard of light is restored and maintained. In my first charge, I found a

condenser without a bye-pass, and the foul main unprotected in the open: and I had recourse to the expedient of uncoupling the condenser-box, and passing the gas direct to the outlet without traversing the pipes. The effect of this, and the wrapping up of the exposed pipes through which gas was passing, was remarkable. The temperature of the gas was kept at a normal degree throughout the winter: the make of gas per ton of coal was increased; while the illuminating power was maintained with a reduced cost for enriching material. As a makeshift, nothing could be better or more quickly carried into effect. All that is necessary is a pipe and tap of sufficient area, connected at a point near the bottom of the condenser-box, sealed in an open seal-pot, and having communication with the tar-well for the carrying off of bye-products as deposited. The tap may be closed and the ordinary process of condensation resumed at will. A proper system of bye-passing should, however, be introduced at the earliest opportunity. I continue to safeguard the temperature, and have within recent years employed slightly heated ammoniacal liquor in condensers and scrubbers for this purpose, with successful results; the temperature of the gas at the scrubber outlet ranging from 55° to 60° Fahr. in winter. The treatment of the crude gas—first with weak liquor, secondly with strong liquor, and finally with clean water, in order to arrest part of the carbonic acid (CO_2), break up the sulphur compounds, and effect the complete elimination of the ammonia—is a process which has been entirely neglected in our small works, and has not received the attention which it merits in works otherwise well equipped.

That it pays to employ washers and scrubbers of an approved kind, or one piece of apparatus capable of accomplishing both objects, has been established beyond a doubt, both as regards the quality of the gas produced and the facility afforded for bringing up the strength of the ammoniacal liquor. In a district like ours, where railway carriage is a heavy item, the importance of sending away highly concentrated liquor, and thus procuring a better price, cannot be too strongly urged. For the larger works, the apparatus referred to is made ready to hand; but in the case of very small works, unfortunately, there are many drawbacks to the installation of a proper system. Here is another opportunity for the exercise of that ingenuity which so readily comes to the aid of the working manager. Why not take advantage of the elevation at which the bulk of the virgin liquor is produced, collect it in suitable tanks, and, having allowed the temperature to fall to that point which will be

sufficient to maintain the gas in the scrubber at 60° Fahr., pass the liquor through the scrubber on its way to the well. It is not necessary, though often convenient, to pass the hydraulic main and condenser liquor to an underground tank after leaving the separator, thereafter returning it to the scrubbers with the pumps. Neither is it essential to have the separator underground. You discover these things when you have no pumps—"Necessity is the mother of invention." The greatest amount of discrimination is necessary, however, in the selection of a washer or scrubber, for many forms of these not only increase the back-pressure, but also materially reduce the illuminating power of the gas.

With regard to dry-lime purification, I find that wherever Mr. G. R. Hislop's rule of 3 square feet of purifier area per 1000 cubic feet of gas made per diem is observed, there is no trouble whatever. When, however, the size of the purifier-boxes is reduced to half of this area, there is no end of anxiety and worry in connection with this most important part of our work. Further, I am of opinion that in every works making gas six days in the week, there should always be three vessels in action, and a fourth standing off to clean, which may be filled leisurely, and remain ready to be turned on at a moment's notice. In this way, immediatelythe second vessel is sulphided it becomes the first of the series, with two clean purifiers always in front.

One of the most unsatisfactory features of our returns is, in my opinion, the large proportion of our production of gas which remains unaccounted for. The fact that leakage can be reduced to a very low figure has been brought home to us time and again; showing that a vigilant oversight of the mains and service pipes and connections has its reward. A valuable aid to the manager and his staff is the practice of rewarding with the trifling premium of 1s. the messenger who reports an escape of gas. It has been carried on in Selkirk during the past two years with very satisfactory results; the amount of gas unaccounted for having been reduced from 10·8 per cent. to a trifle under 8 per cent. Our system of locating a leak is the application of Parker and Lester's gas-leak indicator to gas and water tobies, and to holes made in the ground with the search-rod. Shrinkage of bulk contributes to the unaccounted-for gas; and over it we have very little control. When we advise consumers to safeguard their meters against frost, by carefully wrapping them up, we have used the only means in our power for keeping up the temperature there. In the autumn of 1897 I had thermometers fixed in our manufacturing mains at Selkirk, and made a note of the temperature

there and at several points on the distributing system from time to time throughout the succeeding season. I found the latter ranging from 35° to 40° Fair. in winter: while the thermometer at the station meter recorded 55° to 60° Fair., the temperature of the apparatus leading thereto being under control. We have here a difference of 20° Fair., which, assuming the expansion of ordinary coals at 1/15 of their bulk at 32° Fair., or, roughly, 1 per cent. for every 5° Fair.—the rule laid down by Mr. Newbigging—represents a difference of 4 per cent. in favour of the consumer during the season in which half our yearly output is sold. And this is no very uncommon experience. The largest contributor to unaccounted-for gas is, in many instances, the consumer's faulty meter. The cure for this is the old one—systematic testing and renewal and the introduction of larger sizes than we generally find in use in these parts. Besides these forms of unaccounted-for gas there are many others, which, combined, make it impracticable to lay down a rule, and say that the amount of loss under this head should not exceed a certain limit. It may be argued that a proper basis of calculation is only arrived at when the daily readings of the station meter are corrected to the normal temperature and pressure. This course might be pursued farther, and allowance made for meter-outlet pressure; but an infinitely better plan for the purpose of estimating loss by leakage would be that of keeping a daily record of the temperature of the gas at the governor outlet, which should be compared with the temperature at the station meter, and the discrepancy due to shrinkage brought out approximately. The vital point, after all, is the quantity of gas sold per ton of coal carbonized—having due regard to the cost of the gas into the holder—and as a contribution to the discussion, I give the figures for Selkirk for the year ending May last, which includes arrears, thus reducing the statement to one of gas sold and paid for per ton of coal carbonized—

	Cubic Feet per Ton of Coal Carbonized.	
Gas made		10,313
Gas sold and paid for	9341	
,, sold but not paid for	44	
,, used on works	103	
Total accounted for	9488	
,, unaccounted for	825	
		10,313

There are several other important matters which I should

have brought before you to-day had time permitted, particularly the progress of the gas-stove and coin-meter business in Selkirk, the effect of fixing consumers' burners free, and the advisability of gas companies fitting up and maintaining free of cost a large proportion of incandescent burners in the street-lamps. The public-spirited action of my Directors in fitting up one-third of the public lamps in Selkirk in this manner, has been highly appreciated by the community. These are questions which I propose to open up at our spring meeting next year, all being well.

I have endeavoured to-day to focus your attention upon what I believe to be the essentials to success in the managemant of small works. Managers of such works labour under many difficulties; but, in the carrying out of the operations to which I have referred, there is no reason why we should not emulate the best working returns in the country. Our objects should be: Good carbonizing results, proper control of condensers, effective scrubbing and dry-lime purification, and a small percentage of leakage. We get at these things personally, whereas the managers of large works are dependent upon their assistants to some extent for the carrying out of details.

Discussion.

Mr. J. M'LAREN (Duns) remarked that, as regarded small works, the directors of many of them would not allow the manager to do a great deal of what he would like to do. He proposed a hearty vote of thanks to the President for his address.

Mr. G. TAYLOR (Jedburgh) corroborated Mr. M'Laren's remarks. It was difficult, in small works, to get many things done, for want of money. In large ones, money was often scarcely considered; but in small undertakings the manager had to tell what the cost of anything would be, and he must be sure that he was right.

Mr. VASS said he must express his appreciation of the address; but he thought that many of the points touched on were not so much questions of expenditure as they appeared to have heard them. The introduction of regenerative heating was a matter of pounds, shillings, and pence; and he thought the President had brought out very well the point that it was not long paying for itself, even in small works. As to washing, he thought that the suggestion of the President was not one which would entail a great deal of expenditure; because, if gravity could be brought into play, a little piping would not cost much, and they would have a very valuable purifying agent. But when he used the method suggested, he must always have clean water running

in at the back, and that supply ought to be constant. It was sometimes difficult to get a constant supply of clean water going in in such small quantity as would not make the liquor too weak. If a constant service could not be obtained, the next best thing to do was to put in an intermittent supply, as small as they could get it. He thought the President had brought out splendid results, in both the make and sale of gas.

Mr. W. Blair (Helensburgh) said he had to thank the President for his address. The results brought out were very much what he himself had been obtaining in practice during the last sixteen or eighteen years, which was about the time he had experimented with regenerative and semi-regenerative systems. A manager of small works had to look to the initial expenses—to pay them out of his own pocket, if he were an enthusiast—and it was some time before he could experiment with success. He himself hammered away at the matter; and he was glad to say that he had been successful. When he went to Haddington, the make of gas per ton of coal was about 8000 cubic feet; and, using the same size of retorts, he was afterwards able to turn out from 10,600 to 10,700 cubic feet per ton. The quantity of gas produced per lineal foot of retort, with a 20-inch retort, averaged 1033 cubic feet; so that, as had been proved before, regenerative or semi-regenerative systems could be used in the smallest possible works, and they could be operated at a trifling expense. Such a system really repaid itself in the lifetime of the retort. In regard to self-purification, as he might call it, he had, in nearly all his days of gas making, adopted the principle of utilizing hydraulic liquor as a purifying agent, by allowing the liquor to gravitate from the hydraulic main back to the washer; and it answered the double purpose of strengthening the liquor and picking up impurities in the gas. Besides this, it kept the condenser clean. He had worked condensers for eight or nine years, and had never required to draw a bolt in them. In a works where the gas was often below freezing-point, they would know what this meant. About two years ago, he adopted a rotary scrubber at Haddington. He obtained from 54 to 67 gallons of tar and liquor per ton of coal, with an average strength of liquor of $5\frac{1}{2}°$ to 6° Twaddel, so that possibly everything was absorbed which water could absorb; and the process was automatic in its working. He did not think that even in the larger works they were doing better than he did; and a great many of them were not getting anything approaching to his results. In regard to the unaccounted-for gas, he was of opinion that variations of temperature were not

sufficiently taken into account. He maintained that all meters should be periodically tested—say, every four or five years. He would even go the length of advocating the supply of meters free, and the supervising of the service-pipes to the burner, or at least to the outlet of the meter, so that the manager might have full control of the gas supply to that point.

Mr. H. RUTHERFORD said he concurred in what had been expressed regarding the President's address. They all knew that in small gas-works it was often very uphill work. They had many things to attend to which managers in large works, he believed, knew nothing about; but he thought that, if they put their shoulder to it, they could overcome many difficulties.

Mr. W. M'GIFFIN (Earlston) said that during the time he had been in Earlston the consumption of gas had risen from 400,000 to 1,621,000 cubic feet, and the price had been reduced from 8s. 4d. to 6s. 10d. per 1000 cubic feet. They paid a dividend of about 10 per cent., and had effected many improvements, for which there was a great deal of room; but it was very uphill work. He had adopted the method of taking liquor from the hydraulic main straight to the washer; and by doing so he had reduced the cost of purification by about one-half.

Mr. A. C. YOUNG said he was especially struck with the President's remarks on the subject of regeneration. The regenerative furnace should be in every works, even the smallest. A difficulty which he had always felt, in the case of small works, was that this special system of firing had been patented by several engineers; and managers of small works had a fear that if they attempted anything of their own, they would not succeed. And to go in for any of the patents was out of the question, on account of the expense. He thought, however, that everyone should have the regenerative system. The special saving was not so much in the yield per ton (because this could be got from ordinary shallow furnaces) as in the quality of the coke. They could use shale, or almost any sort of coke, in the furnaces; and they could fill up the furnace at night, and find it ready to start in the morning—thus doing away with damping down. This led to the saving of the retorts, because, as they knew, the letting down and getting up of the heat knocked the retorts to pieces. As to leakage, there was a point which, he thought, was apt to be lost sight of—viz., the high pressure required to be kept up during the day for gas-cookers. In many works there was no governor; and the full pressure was on the works night and day. The loss by leakage was in this case enormous.

Mr. M'GIFFIN mentioned that he had a gas consumer who

had seventeen burners, a gas-cooker, and a gas-stove, and only a ½-inch pipe supplying them. He could not get this consumer to allow a bigger pipe to be put in, as he insisted that it was the pressure at the works which was at fault.

This closed the discussion on the President's address.

Mr. VASS introduced the subject of the standardizing of meter-unions, which, he said, had been rather dropped by the North British Association, but which, he thought, they should not drop; and he proposed that they should continue the Committee they had on the subject.

Mr. W. BLAIR thought they had the matter in their own hands, as, if they ordered meters of a uniform standard, they would get them.

Mr. D. M. NELSON (Glasgow) supported Mr. Blair's views.

Mr. VASS's motion was agreed to.

Mr. VASS asked the opinion of the members upon the subject of stove-hire. He remarked that at present the customary charge was 10 per cent. per annum. There was this difficulty—that as new stoves came out, hirers were apt to return those they had, and ask for the later ones. It had been suggested that, to obviate this, the hire should be reduced after five years.

Mr. M'LAREN said that his consumers preferred to purchase stoves outright.

The PRESIDENT thought that if a consumer hired a stove for ten years, he should get the stove as a present, as it would have yielded a sufficient return in the amount of the hire and the revenue from gas consumed.

Mr. YOUNG said he favoured the supplying of cookers free, so as to encourage the consumption of gas.

The PRESIDENT thought this would be creating a differential rate, to the prejudice of the ordinary consumer.

The meeting was then closed.

The members and friends, including ladies, dined together in the Station Hotel. The toast of "The Waverley Association" was proposed by Mr. A. Gillespie, of Glasgow; and that of "Kindred Associations," by the President, and responded to by Mr. D. M. Nelson. In responding to the toast of his own health, the President said that the Waverley was the most friendly of all Associations. It had existed in amity for nearly forty years without a rule or a bye-law. Afterwards the party visited Melrose Abbey, under the guidance of Mr. W. Smith, Engineer and Manager of the Melrose Gas-Works.

EASTERN COUNTIES ASSOCIATION.

HALF-YEARLY MEETING, SEPT. 20.

This Meeting was held in the Town Hall, Sleaford. There was a large attendance of members, associates, and friends; among them being Mr. E. H. Stevenson, the President of the Gas Institute. At one o'clock the party assembled at the gas-works, which for a long period have been under the management of Mr. Harry Wimhurst, the President, and one of the founders of the Association. After luncheon, kindly provided by the Directors of the Sleaford Gas Company, there was an inspection of the works, which, since the last visit of the members, had undergone considerable reconstruction. Well ordered and splendidly kept was the unanimous comment upon the buildings and plant. On leaving the works, the visitors walked to the Town Hall, the use of which had been courteously placed at their disposal by the Kesteven County Council.

During the transaction of the preliminary business, the chair was occupied by the retiring President, Mr. W. D. CHILD, of Romford.

A WELCOME.

Mr. CHILD, on taking the chair, claimed the attention of the members for Mr. H. A. Peake, Chairman of the Gas Company.

Mr. PEAKE said it was his duty to bid the members a hearty welcome; and he did so with the greatest pleasure, for he recognized in the Association an organization which had been founded more for the benefit of those interested in the production of gas as shareholders and consumers than for the members themselves. This showed how deeply the members were interested in the profession to which they had devoted themselves.

Mr. CHILD said the members were much gratified with the kindly reception which Mr. Peake had accorded them; and, in return, he could assure that gentleman that they were really delighted to be present to support their incoming President, who was a popular member of the Association, and had been of the greatest possible service to it. He might say that, had it

not been for Mr. Wimhurst, it was doubtful whether the Association would have been in existence. He started it, and had worked thoroughly well to bring it to the position which it now held among Gas Associations. They were glad to know that the Sleaford Gas Company was represented by so efficient an Engineer as Mr. Wimhurst.

Minutes of the Last Meeting.

The Hon. Secretary (Mr. J. H. Troughton, of Newmarket) read the minutes of the spring meeting at Cambridge; and they were confirmed.

New Members and Associates.

The next business on the *agenda* was the election of new members and associates. To the former class, Mr. H. Kitson, of East Dereham, and Mr. Sidney Francis, of Clacton-on-Sea, were admitted.

Mr. Child then read the names of the gentlemen submitted by the Committee for election to the class of associates established by the rule passed at the spring meeting. They were: Mr. H. J. Davis, Mr. John G. Glover, Mr. F. Lennard, Mr. W. J. Jenkins, Mr. J. A. Drake, and Mr. J. H. Sheldrake.

Mr. J. G. Hawkins (Spalding) proposed the election of these gentlemen as associates.

Mr. Wimhurst remarked that the names submitted had been before the Committee, who had given them every consideration; and he had much pleasure in seconding the proposition.

The motion was unanimously agreed to.

The New and Retiring Presidents.

Mr. Child said he had now only to ask Mr. Wimhurst to take the chair.

The President, who was heartily received, said his first duty was to propose a cordial vote of thanks to their retiring President for the very able manner in which he had conducted the affairs of the Association during the past year. Connected with the Association as he (Mr. Wimhurst) had been from its birth, he knew of no President who had carried out the duties of the office with greater distinction and ability than Mr. Child.

The proposal was heartily endorsed by the members.

Mr. Child, in acknowledging the vote, said he felt sure it was rather his duty to thank the members than to receive their thanks for what he had done during his term of office.

The President then delivered his Inaugural Address.

PRESIDENT'S ADDRESS.

Gentlemen,—My first duty as your President is to thank you for the honour conferred on me by electing me to the chair of this Association—a compliment I much appreciate. At the expiration of my year of office, I hope to hand the presidency over to my successor in the same satisfactory manner as our late President, Mr. W. D. Child, has handed it down to me. I accepted the position of your President knowing I should have the support of the Past-Presidents, Committee, and members generally, and knowing also that there are other gentlemen more able than myself to occupy this chair. But as I consider it the duty of each individual member of the Association to allow himself to be nominated for any office the members wish him to fill, I trust to receive the hearty co-operation of every member during my term of office, in making the work of the Association interesting, useful, and beneficial to the gas industry at large.

We may congratulate ourselves on the continued growth and prosperous condition of the business we have so much at heart, and in the interests of which we have met here to-day; and I trust each one of us will leave this meeting having learned some little lesson from the rubbing of shoulders together with his professional brethren.

You are all well aware of the greatly increased cost of our raw material during the past three years. In most cases coal has advanced as much as 2s. 9d. to 3s. per ton; and during the same period residuals have not advanced proportionately. Indeed, on the other hand, taking the average, a much lower price has been received for coke, tar, and ammoniacal liquor during the period named. It is only in the past few weeks that there has been any indication of an advance in this direction. I hope the rise will be increasingly maintained; for, as far as one can see at present, there is no possibility of coal being cheaper for a very long period, owing, I have no doubt, to the prosperous condition of the trade of this country, which we are all glad to see, and which we wish may be continued for a lengthened period. With regard to our coal supply, it has occurred to me that the combination of the coalowners has had much to do with the increased price we are called upon to pay. If this combination is good for the coalowners, why should not a similar power be set in motion to advance the prices of residuals, by the combining of gas-works in particular districts? If such a thing could be done—and I think it could—it would be better for all concerned. We all know that coke, especially in our particular district, is sent from the larger into the smaller towns at a low rate; and

this very much hampers managers of small undertakings, and prevents them getting a fair and equitable price for the coke produced. We know co-operation can do a great deal; and in this particular direction it is most desirable that we should be up and doing. One also finds combinations among the makers of other manufactured articles we have to purchase—such as meters, stoves, tubes, &c.; and if it is of benefit to producers of these goods (of which there is very little doubt), surely a fair and reasonable combination for the sale of residuals would be most beneficial to all interested in their manufacture.

Carburetted water-gas plant is being largely introduced in this country. The causes of this, no doubt, are the ease with which a large quantity of gas can be manufactured, the increased cost of coal, the low price obtained for coke, and the small space occupied by even a large plant. As, however, we are to have a paper upon this subject to-day by Mr. Carter, I will leave it in his hands.

Vast improvement has been made in carbonizing plant during the past few years by the adoption of regenerator furnaces in place of direct firing; and this has done much to lower the cost of production, and has secured easier and more comfortable working for the stokers. In my own case, since the putting down of regenerators of the Winstanley type, we have been enabled to work with 50 per cent. fewer retorts, and have had a greatly increased make per annum; and this with a less sum for wages. The saving in fuel has more than paid the total cost of the regenerators and settings. During 1898, my Company sold 10 cwt. 2 qrs. 23 lbs. of coke per ton of coal carbonized, after providing fuel for the steam-boiler and the blacksmith's shop. Beside this, there was a large percentage of loss by the breaking of the coke; about 40 per cent. of our manufacture being sold in this condition, and the amount of small ash being not less than 1 cwt. for every ton of coke so treated. If our works had been sufficiently large to have constructed benches of through retorts, so that one regenerator could have been employed to heat the through setting, the economy would have been very much greater.

The vexed question of stopped ascension-pipes is, to my mind, one easy of solution. If engineers and managers will be satisfied with working at not too high a heat; if they will secure a proper and even distribution of the coal on the floor of the retort; charge the retorts up to their full working capacity; prevent any tar accumulating in the hydraulic mains; maintain a light seal of, say, ¾ inch; and run the exhauster at level gauge—they will,

in my opinion, be able to work free from the fault alluded to above, avoid anxiety, and produce gas of fairly good quality, compatible with the quality of the coal carbonized.

Inclined retorts will now, no doubt, be more extensively used than formerly in large and medium-sized works; the patent question having been settled in favour of the gas manufacturers, although it does seem very hard upon the Company owning the patent that they should not have had an extension of time granted them, seeing they made nothing out of such a useful invention. This system, combined with charging and drawing machinery, will do much to lessen the cost of manufacture.

Condensation, washing, scrubbing, and purification, are all subjects which some of our members would do well to bring before us for discussion by means of papers at the next spring meeting of the Association; and a further paper from our esteemed friend Mr. Shadbolt, upon his tar-enrichment process, would be most acceptable and interesting to the gas profession generally.

One of the greatest questions before us at the present time is the public lighting of our streets. Gas consumed by the flat-flame burner represented all gas could do for very many years. But the introduction of electricity in our streets and public places aroused the gas industry to a sense of its proper position in the matter; and I am glad to say it has been equal to the occasion, for now most towns of any standing have their installations of incandescent gas lighting—very much to the annoyance of the purveyors of electric current. When such towns as Liverpool, Bradford, Leeds, Bolton, and others, owning their own electrical works, use incandescent gas-burners very largely for lighting their streets and thoroughfares, the public may rest assured that they have not only adopted the best and most satisfactory system of lighting, but the most economical. Some of the provincial towns have large numbers of incandescent burners doing excellent duty in public lighting. Among them are Liverpool with 7000 burners, Sheffield 3400, Bradford 2112, Wolverhampton 1559, Ipswich 1313, Oxford 1230, Huddersfield 1000, Ramsgate 975, Dover 921, Manchester 900, Douglas 851, Maidstone 850, Eastbourne 795, Southend 552, and Winchester 500. The most singular point about the above figures is that in most of the places named the town authorities own the electrical works, where such works exist. The best installation of public lighting it has been my privilege so far to see is on the promenade at Douglas. This magnificent piece of gas lighting, 1¼ miles in length, is accomplished by 93 Bray lamps of the hexagon type, fitted with 3-light

clusters of the No. 4 Kern and ordinary "C" burners, consuming 12 cubic feet per hour each lamp; the average candle power of each lamp being 180, or an effective lighting power, for the 1¼ miles, of 16,740-candle power. There are also 27 similar lamps in other parts of the town. The whole are lighted from sunset to midnight with the three burners in use; after midnight till sunrise, one burner only is employed. This is for the three summer months; and for the remaining nine months 60 of the lamps are employed with one burner only. The cost to the town for a three-years contract is £281 12s. 6d. per annum, inclusive of all charges. The lamps are arranged in two lines, one on either side of the promenade, at distances of about 53 yards apart, and are placed in diagonal lines from the inner to the outer circle of the promenade. Any gentleman interested in public lighting would do well to inspect this piece of outdoor illumination.

In this town, the members will find the main streets fitted with improved lanterns and No. 4 incandescent Kern burners. The lighting is very effective, and is giving great satisfaction to the majority of the ratepayers. The charge is £1 18s. 6d., inclusive, per lamp per annum, of 1500 hours—a sum which, I think you will all agree, is most moderate, if not under the mark. I may add that my Company made the Council an offer to light the whole of the district in this manner, if we could be assured of a four-years contract; but as the Council have decided to promote an Order to supply electricity, they could not, in their wisdom, accept the Company's offer.

The prepayment system for gas consumers shows no sign of abatement in its popularity; the ever-increasing orders received by the makers of these meters taxing their capabilities to the utmost. In this town, as most of you are aware, we introduced the system in 1893, and have now on our books 370 prepayment, or cash, consumers. During the six years the system has been in use with us we have supplied, to the 30th of June last, 10,737,300 cubic feet of gas to this class of consumer; and the receipts, inclusive of meter and fittings rent, have been £2463 4s. 6d. They now average between £500 and £600 per annum. But for the invention of the prepayment meter, I venture to state we should never have received a tenth part of this income from new consumers of the class supplied. No doubt similar, or better, figures than the foregoing are obtained by many of you.

Gas-engines are also an ever-increasing source of revenue to the gas manufacturer. Hitherto they have only been used up

to moderate sizes; but we must all be pleased to note that makers are turning their attention to engines of very much larger power. Lately, Westinghouse gas-engines of 150-horse power have been put down at Chelsea for generating electricity, and, according to the "Engineer," are running very satisfactorily; the governing of the engines being most perfect, though running at a speed of 240 revolutions per minute. I believe, however, Messrs. Crossley Bros., Limited, have made engines of even larger power than the above. It is pleasant to notice that tramcars driven by gas power are giving great satisfaction at Blackpool, Trafford Park (Manchester), and Neath. These cars have engines of 14 brake horse power; and the consumption of gas per car-mile is about 30 cubic feet. From this source the larger towns may, in the near future, have some very large consumers of gas.

The question of interior fittings is a matter for all gas undertakings to take up, and, by the aid of a good show-room in the centre of each town, to educate the public as to what can be done for them in illumination, cooking, heating, and power, and in other directions in which gas can be usefully and economically employed. I would suggest to each of our members (if they have not already done so) that they should supply to consumers any and every appliance they may require for gas consumption at net cost price, including the fitting of same, and see that the goods so supplied are fitted up in the best possible manner, so as to give the most satisfactory results. An inspector told off for this special work, and to advise consumers, would repay the outlay many times over, where the works are sufficiently large to employ such a servant.

In connection with supplying fittings on hire, which most gas undertakings now do, I see the High Wycombe Gas Company have gone further, and are letting gas-engines on simple hire, or on the hire-purchase system. The Company are to be highly commended for this bold policy; and I trust they will receive the reward they so richly deserve. I think their action might well be followed by many other companies, where there is any demand for gas-engines.

The gas-consuming public will have pleasure in welcoming in the New Year the new incandescent burner and mantle of the Voelker Company, at the very moderate price of 2s. If this burner and the mantle are as perfect as the Company lead us to believe, there will be an immense field opened up for incandescent gas lighting. Surely, then, this will be the poor man's light, as also it will be the light of the more wealthy; and it

will, in my opinion, prove a great check upon the purveyors of electricity.

Before closing this address, there is one matter I should like to mention—and that is the desirability of an amalgamation of the Gas Institute and the Institution of Gas Engineers. The time has now come when there should be no division in our ranks; and Associations such as this should have only one head or parent Institution, and not two, as at present. I think that both of the Institutions, and all the District Associations, should send representatives to a meeting to be called by, say, the Honorary Secretaries of the Gas Institute and the Gas Institution, and let the matter be thoroughly discussed and threshed out, and a scheme prepared for the union of the two bodies. As the article in the *Journal of Gas Lighting* for Sept. 5 states, let the century now fast approaching its end close in peace and unity, at any rate as far as the Gas Institutions are concerned.

In conclusion, gentlemen, I have to thank you for your attention to the few remarks I have made; and I trust that each ndividual member will try and make the Association a model of what such a body should be. This can only be done by the members coming forward and contributing papers, and discussing the papers so read in a thoroughly practical manner. I trust that my year of office will see a great improvement in this direction, and that the work of our esteemed Honorary Secretary may be made much lighter by gentlemen offering their services in the preparation and reading of papers upon subjects of interest to the profession.

Mr. E. H. STEVENSON said it was his pleasure to ask the members to accord to the President a hearty vote of thanks for the address he had just delivered. As he listened to it, he heard a great many interesting points, which perhaps appealed more to the members than they did to him; for, as they were well aware, he did not now personally manage a gas-works. There was, however, one point towards the end of the address which did interest him very much; and he hoped that it equally interested everyone who heard it. He referred to the remarks made as to the advisability of "burying the hatchet" among the different members of the gas profession, and of there being one parent society, strong and healthy. He (Mr. Stevenson) could assure those present that he should work as strongly as he could for this purpose during his year of office as President of the Incorporated Gas Institute; and he hoped they would all

work earnestly for it. He was glad to have had the opportunity of proposing this vote of thanks to the President, and trusted his wishes would be carried out in the letter and in the spirit.

Mr. R. G. SHADBOLT (Grantham) said he had been looking forward very anxiously to this address of Mr. Wimhurst's. The Eastern Counties Association had a district peculiar to itself; and he thought, if they scanned the address from one end to the other, they would find it was admirably adapted to the views and requirements of the district the Association covered. He had been much struck with the latter part of the address; and he might say that he had also read the admirable leader in the *Journal of Gas Lighting* to which the President had referred. It appeared to him that they wanted some central authority to whip them into shape, and to bring them together. They heard a lot about two parent Institutions, which was wrong —the fact of the matter being that they had one parent Institute and an obdurate offspring. (Laughter.) He thought they could very easily, if they were only brought together, end the century in peace and unity. He had much pleasure in seconding the vote of thanks.

The motion was carried by acclamation.

The PRESIDENT said he was extremely obliged to the members for their vote.

Mr. J. CARTER (Lincoln) then read the following paper:—

THE RECENT COMMITTEE ON CARBURETTED WATER GAS.

The subject of the manufacture and supply of carburetted water gas has been so prominently before the members of the gas profession during recent years, that you are all more or less conversant with it. The plant necessary for its production, and the method of manufacture, have been so fully described, its cost in comparison with coal gas so carefully stated, and its advantages as well as its dangers so frequently discussed in our technical Press, at District Association meetings, and at various meetings of the Gas Institute, that probably no useful purpose would be served by making any reference (except in an incidental way) to these particular aspects of the subject at the present moment.

Recognizing the fact that carburetted water gas has come to stay, and in view of its rapidly extending use in this country, the Home Secretary, in February of last year, appointed a Committee to inquire and report on the extent to which water gas is manufactured and used, the danger attending such use, and the means to be adopted, and the regulations to be imposed by

which such dangers may be diminished or removed. Among the witnesses examined were gas engineers of high position (some engaged in the manufacture of carburetted water gas and coal gas, others making coal gas only) well-known scientific experts, and others who, rightly or wrongly, were doubtless perfectly sincere in the alarm with which they regarded the growth of the manufacture and supply of carburetted water gas. The Committee included scientists of the highest reputation. All the materials necessary to a complete and exhaustive inquiry into the subject were provided; and the result, as we find it embodied in the report and recommendations, is of such importance and weight as to demand universal respect.

The increasing use of carburetted water gas rendered an inquiry by some independent and central authority absolutely necessary. It had already been too long delayed. The position of the companies and corporations in possession of gas-works who desired to extend their producing power by the installation of carburetted water-gas plant, was a most unsatisfactory one. In the case of companies having unexhausted capital powers at their disposal, the directors, aware that such plant was not contemplated at the time their parliamentary powers were obtained, could not be quite satisfied that it was a legitimate use of the capital they were authorized to raise. The position of corporations was very much worse. An application for power to borrow money for the purpose of providing plant of this description, was sure to be met with a refusal. It has been suggested, however, that if the provision formed part of a large and general scheme, without a definite statement of the fact, it would be allowed to pass without any inconvenient questions being asked in relation to the matter. Such a position ought not to have been tolerated for one moment longer than the time necessary for the most comprehensive inquiry into the subject. The position I have indicated was not creditable to the central authority, and was simply intolerable to those who were placed in the control of gas-works. An industry which finds profitable employment for nearly one hundred millions of money, and for many thousands of men, ought not, in the discharge of its statutory obligations to the public, to be driven into a policy of subterfuge and suppression. Either the supply of carburetted water gas constitutes a public danger without any compensating advantages of a sufficient character to justify its adoption, or it has possibilities of public service of such an important nature that its manufacture and sale ought not to be prohibited. Upon this point, we have in the report a deliverance on the part

of a most competent authority, arrived at after full and complete investigation—a deliverance which, whether its recommendations are embodied in subsequent legislation or not, may be regarded as having closed the controversy upon the subject, as far as the public mind is concerned. If any attempt is made to legislate upon the matter, it is reasonable to suppose that the safeguards and restrictions indicated in the report represent the maximum that Parliament will be likely to impose.

The Committee have accomplished much in the direction of clearing the public mind of a misconception very generally entertained as to the character of carburetted water gas. The idea prevails that it is entirely devoid of smell; and to this fundamental error may be traced much of the opposition that exists, and almost all the objections that are urged against its manufacture and supply. In correcting this popular mistake, the Committee have rendered useful public service. That carburetted water gas possesses a pungency of odour that renders the slightest leakage as easily detected as an escape of coal gas, is to us a matter of common knowledge; and we did not require the accumulated evidence of the several witnesses examined before the Committee to convince us of the fact. It is of such an elementary character that an apology is almost required for making special reference to it. At the same time, I am convinced that we shall have to state and re-state this fact, rudimentary as it is, over and over again, before it is generally and clearly understood by the public, and before the opposition to the development of the manufacture of carburetted water gas is finally overcome. The provision of a plant for Lincoln has been under our consideration for some time; and the objection most frequently heard has been grounded upon the supposed inodorous nature of the gas. This mistake is not confined to the man in the street. Not long ago the subject of carburetted water gas was discussed by one of our provincial Councils, when the Mayor—a gentleman with many years' experience of public business behind him—stated that the great objection to the gas is that it has no smell. We shall do well, therefore, to seize every opportunity of bringing to the notice of the public the following statement of the Committee upon this point: "For lighting, and in some degree also for heating, purposes it is necessary to enrich the gas with oil. In this process, which is known as carburetting, the oil is vaporized and thoroughly incorporated with the gas, thereby giving its flame luminosity, and also imparting to the gas a decided smell, similar to, and fully as noticeable as, that of ordinary coal gas. Again, an

escape of carburetted water gas is as easily detected as one of coal gas, and, except in very special circumstances, can be avoided or remedied long before the atmosphere is in the least degree poisonous."

The effect of the report will doubtless be seen in a considerable increase in the number of installations of carburetted water-gas plants in various parts of the country, the probability of which was evident to the Committee, who say: "We are, however, satisfied that the advantages which many gas managers see in carburetted water gas may well lead to an increase in its use." These advantages, which were proved in the evidence of the several gentlemen who were examined, may be briefly stated as follows: Great saving in first cost of plant. Perfect control of candle power of gas made. Effective control of the coke market. Prevention of trouble from naphthalene deposits. Great saving in labour involved in manufacture. Practical independence of coal supplies during colliers' strikes and lock-outs. Prompt availability in case of emergency.

The whole of these points are invested with some measure of importance in the estimation of gas manufacturers; and several of them present considerations of great moment and value. The effect of the manufacture of carburetted water gas upon the coke supply, and, consequently, upon its market value, is a matter the importance of which may be very easily underestimated. Mr. George Livesey stated, in the course of his evidence, that the difficulty in disposing of surplus coke is the one condition that would, he thought, force the South Metropolitan Gas Company to make carburetted water gas. The improvement in the coke market effected thereby is not confined to those actually engaged in the manufacture of carburetted water gas, but is universal in its operation, and will extend to our own widely scattered district. We may have no repetition of the unpleasant experiences of former years, when in our immediate neighbourhood the market has been flooded by low-priced coke from the great towns.

The certainty of maintaining the gas supply during colliery disputes is an advantage attending the use of a carburetted water-gas plant to which I attach considerable importance. During the protracted strike or lock-out of six years ago, the purchase of coal outside of contracts cost us in Lincoln nearly £2000, and most other places usually dependent upon the Midland district proportionately as much. Most of this extraordinary expenditure, and the constant anxiety occasioned by an uncertain coal supply, which extended to the end of November

in that year, would have been obviated had a water-gas plant been available. These advantages, with which we are all more or less familiar, and of which the Committee appear to have been convinced, were stated very clearly and forcibly in the evidence of such capable witnesses as Mr. A. G. Glasgow, Mr. George Livesey, Professor Vivian B. Lewes, Mr. William King, Mr. J. T. Westcott, Mr. A. C. Humphreys, Mr. Corbet Woodall, and others.

There is, however, one other consideration of a general character that is worthy of note in favour of carburetted water gas —and that is the economy in the consumption of coal that is effected in its manufacture. We are told that we are drawing upon our sources of coal supply to the extent of upwards of 200,000,000 tons yearly; and of this enormous annual tonnage 13,000,000 tons are used in the manufacture of illuminating gas. If the idea that we were taught to cherish in our youthful days—viz., that our known coal supply is practically exhaustless, and is capable of supporting this tremendous output for an indefinite series of centuries—had remained unshaken, then in that case, I admit the saving of 2,000,000 or 3,000,000 tons a year in the manufacture of gas would not be a matter of serious moment. But is this so? Mr. Forster Brown, the President of the Mining Association of Great Britain, in the course of a lecture at the Society of Arts, in April last, stated that the best of the coal resources at a moderate depth of 2000 feet, and of the best quality, cheaply worked, would last about fifty years.

To my mind, the bare fact that gentlemen of position who are qualified by their peculiar knowledge of the subject, suggest that the exhaustion of our supply of cheap fuel may be within measurable distance—and that not a very remote one—is very significant indeed. The employment of any and all of the resources of science and civilization in economizing the consumption of coal assumes, in the light of this fact, an importance which is not confined within the comparatively narrow limits of the gas industry, but is a matter of national moment. It is stated in the report that "in Great Britain there is at the present time plant capable of making between 70,000,000 and 80,000,000 cubic feet of carburetted water gas per day. If this plant were worked to its full capacity every day in the year, it would produce an amount of gas equal to about 24 per cent. of all the illuminating gas supplied in the year 1897-8 in Great Britain." Assuming it reaches this proportion, then a calculation based upon 1 ton of coal yielding 10,000 cubic feet of gas and 10 cwt. of coke, available for the manufacture of (say) 30,000

cubic feet of carburetted water gas, shows a saving in the consumption of coal of nearly 2,500,000 tons per annum. Certainly, this tonnage bears no great proportion to the total annual output; but when you are dealing with a matter so vital to our industrial existence as our cheap coal supplies, and so uncertain in its duration as some of our authorities say it is, then, I think, any proposal by which economy in its use can be effected is worthy of something more than a passing thought. When the provision or otherwise of carburetted water-gas plant is under discussion, I do not say this saving should be a determining factor, but I do say it is worthy of some consideration when the probable advantages, and possible disadvantages, of an installation of this character are being weighed in the balance.

It was not, however, to learn what advantages could be claimed for carburetted water gas that I awaited this report with such deep interest. We are all well informed on these matters. They have provided material for presidential addresses at our various meetings; and the manufacturers of the plant have been most careful—and naturally so—to ensure that we shall not suffer for lack of knowledge in this particular. What I was most anxious to learn was, whether the inquiry would reveal any disadvantages of such importance as to justify any reasonable doubt as to the advisability of its adoption.

First, as to its cost in comparison with coal gas. After all, this is the standard by which the question is judged and, to a large extent, determined; and, although the Committee in their report do not discuss the economic advantages and disadvantages of water gas, in the course of the inquiry evidence was tendered relating to this aspect of the case. I need not prolong my paper by quoting the figures given in evidence, and others which have been published in our technical journals. The question of cost is largely one of locality. Gas-works situate in close proximity to rich gas-producing coals, or enjoying exceptional facilities in the way of low freights, can make coal gas at a lower cost into the holder than carburetted water gas; but in most places the latter will be the cheaper to produce. I am tempted here to ask: Why, in computing the relative cost of the two gases, do we invariably make the comparison at the holder? Do we get a fair and accurate estimate at this point? I think not. By this method we altogether omit from our calculations one charge that, in the case of carburetted water gas, is exceedingly light as compared with coal gas. I refer, of course, to the interest on capital. When capital charges are taken into our calculation of the relative cost of the two gases—as I hold they should

be—then I do not think it requires any excessive boldness to state, as a matter beyond the possibility of successful contradiction, that in the great majority of the gas-works of the United Kingdom carburetted water gas can be produced at a considerably lower cost than coal gas.

Reference was made to the effect of the gas upon ordinary burners; and it was shown that some trouble was occasioned by stoppages owing to the deposit of carbon at the point of the burner, where unmixed water gas was supplied. But when it was sent out mixed with coal gas, this difficulty entirely disappeared.

We have, then, only one serious objection to consider—viz., the alleged danger attending the use of carburetted water gas, and arising from the nature and composition of the gas itself. The statements of the report may be summarized as follows:—

Coal gas contains a percentage of carbonic oxide varying from 4 to 12, according to the kind of coal used and the particular conditions of manufacture.

Carburetted water gas contains about 30 per cent. of carbonic oxide.

The poisonous action of coal gas and water gas is due solely to the carbonic oxide which they contain—that the higher the proportion of carbonic oxide, the greater is the poisonous property of the gas. This assertion was challenged; but it is stated as the unanimous opinion of the Committee.

The danger increases at a much greater ratio than the proportion of carbonic oxide.

The report states, further, that the circumstances under which carburetted water gas may be seriously dangerous are comparatively few. In the daytime the amount of carbonic oxide is not of serious consequence; and even at night slight escapes—say, from leaky joints—are not rendered more formidable by the presence of carburetted water gas. The suspicion of the cumulative effects of the gas is dismissed with the remark: "We do not think that the existence of anything like chronic poisoning by carbonic oxide has been established."

We are told that "the prospect of any serious result from the distribution of gas containing a high proportion of carbonic oxide, is practically confined to cases of large escapes into rooms where persons are asleep." This statement possesses great interest and importance. In these few words, we have focussed the result of the inquiry into this feature of the subject.

Its meaning really is that, whatever may be the scientific theories formed on the matter, in practical life the only circumstances under which serious consequences would arise from an escape of carburetted water gas are precisely those conditions which would produce equally serious results in the case of ordinary coal gas.

These excerpts fairly represent the mind of the Committee on the subject of danger. They are supported by a mass of statistics, English and American—for obvious reasons, chiefly the latter. These statistics are certainly not entitled to the importance given to them in the report. The conditions of life which provide such a fruitful contributory cause of these accidents across the water, do not exist in English towns; therefore the deductions drawn from the figures as to the probable accidents in this country, if water gas were supplied to the same extent, are entirely illusory. I have not the chemical knowledge to enable me to controvert these statements, nor the special information requisite for an effective criticism of the statistics which appear in the appendix. If I had, I should prefer to leave the matter in the hands of such authorities as Mr. A. G. Glasgow, who devoted his extremely able Gas Institute lecture to a consideration of this particular feature of the report.

Arriving at the conclusions I have quoted (the accuracy of which, for my immediate purpose, I may admit), it is only natural that the Committee should follow with the recommendations with which they conclude their report, and to which, in closing my discursive paper, I wish to draw your attention. They are, briefly, as follows:—

That it should be illegal to make and distribute any poisonous gas which does not possess a distinct and pungent smell.

That in all applications for statutory powers to make and distribute gas, the kind of gas to be so made and distributed should be stated.

That due public notice should be given of the proposal to supply any kind of water gas; and, so long as such supply continues, the fact should be stated on demand notes.

That records should be kept, where water gas is distributed, showing the respective quantities of the gases issued, distinguishing the day and night supply; and that these records should be open to inspection, and be published quarterly in a local newspaper.

That power should be conferred upon a Central Department to limit the proportion of carbonic oxide in the gas supply at night to 12 per cent., or such greater amount as the Department may consider desirable.

That power should also be given for the regulation of the distribution and use of gas, by means of bye-laws made subject to approval by a Central Department, and administered under local control. The matters to be so dealt with might include the hours during which the limit of carbonic oxide should be enforced, the extension of that limit in emergencies, the character of internal fittings, and other similar questions.

That sections 28 to 34 of the Gas-Works Clauses Act, 1871, should apply to the testing of gas for carbonic oxide, and that some person should be required to make such tests and publish the results periodically.

Some of these recommendations are not of much importance, and, if adopted, appear to me to be so entirely incapable of good or ill that we need not stay to discuss them. The fifth and sixth, however, are of great moment. They represent the principal result of the inquiry, and fix the limit to be observed in the quantity of water gas sent out in the night supply. That some restrictions should be suggested, is not surprising. In deference to public feeling, which, in narrow circles, had been needlessly excited, it was, perhaps, inevitable. I do not regard it as any reflection upon the Committee to say that apparently the object of the inquiry was not so much to ascertain whether any restrictions were advisable or necessary, as to determine the extent to which they should be imposed. At the same time, the statement that I have already alluded to, that serious danger from the use of carburetted water gas is practically confined to cases of large escapes in rooms where persons are sleeping—a danger, bear in mind, as certainly existing with coal gas—it is not easy to understand how it can be removed or diminished by any limitations to be placed upon the proportion of carburetted water gas.

The question remains: Are these restrictions of such a nature as to hamper those who are now supplying the mixed gases, or give pause to those who intend so to do? I think not. The report evidently contemplates the very liberal use of carburetted water gas during the day; and it is in the daytime rather than at night that those sudden fluctuations in the consumption of gas are experienced which create the emergencies with which we have to deal, while the night limitation of carbonic oxide will

admit of the distribution of (say) 25 per cent. of carburetted water gas. The proportion allowed will suffice to meet the necessities of those whose chief purpose is to use the gas in case of emergency, and will be of great service also to those who rely upon it for a part of their normal and regular supply. The conditions set forth in the report, while they have regard to the public safety, leave ample room for the useful employment of carburetted water-gas plant upon many of the gas-works in the United Kingdom.

Discussion.

The PRESIDENT having invited discussion,

Mr. R. G. SHADBOLT (Grantham) said they were informed from time to time that those who had had no practical experience in the manufacture of water gas had no right to speak upon it, or something to that effect. He did not know if Mr. Carter had got to work yet with his water-gas plant; if he had, he would escape the wrath of the gentlemen to whom he referred. But unfortunately for himself, he had not made water gas, except when putting out a coke heap that had fired. (Laughter.) At any rate, he had listened with interest to Mr. Carter's able paper; and he thought he might venture to say a little in the way of criticism. The title of the paper was "The Recent Committee on Carburetted Water Gas." Now, one generally looked at the title for some idea as to what he might expect before he actually read the text; but the title in this case did not indicate all that really followed. If the author had not adhered to his title in the body of the paper, he had done so in both the beginning and the end of it; and it was there they had to look for the drift of the work of the Water Gas Committee. The object of the Committee's work seemed to be one of the principal points that Mr. Carter intended to bring out; and it was, he (Mr. Shadbolt) took it, not so much to elucidate technicalities for gas suppliers, or to solve financial problems, as to protect the public. Whether the protection was actually required or not, had little to do with them as gas suppliers. The public were the people they had to supply; and they had to supply them under control from head-quarters. And if the Government took it into their heads to appoint a Committee to inquire into this or that, if the public got a scare (whether rightly or wrongly), they had a perfect right to do so—not so much to hamper them in their gas-manufacturing operations (that was a mere side issue), as to restrict, within safe limits, the increased proportion of a gas acknowledged to be highly

dangerous if breathed. The Committee evidently recognized this, and reduced it to a question of degree. It was quite true that gas was not made to be breathed; and it was likewise perfectly true that they had to deal with defective conditions. He had waded through all the evidence laid before the Committee; and he had come to the conclusion that they fully recognized the question of degree as one of most vital importance. According to the evidence placed before them, they were quite right. This evidence proved, to their conviction at any rate, that increasing the proportion of carbonic oxide in any illuminating or other gas which might escape, increased in a greater ratio the dangerous, or rather the poisonous or toxic, property of the gas. He thought this was the point the Committee were aiming at; and to his mind they were quite right in going into the matter as they did. It must not be overlooked, in considering the position of the public in connection with this question, that they had, as he had already mentioned, imperfect conditions to deal with. They as gas managers might deplore this; but they must not blame the public too much if they took alarm at the increased danger. As to the danger being reduced at night time, or reducing the danger in the night period, he thought the public had every right to be protected during sleeping as during waking hours; and although the effects of carbonic oxide poisoning might not be cumulative, he failed to see that this was an argument for unnecessary exposure to an increased danger. He agreed with the author to some extent that, where water gas was of real advantage, the recommendations of the Committee put no insurmountable barrier in the way, although they curtailed somewhat the field of operations. The author had also dealt incidentally with certain "advantages" of water gas; and therefore he (Mr. Shadbolt) should not be out of order in making a few incidental remarks upon them. To his mind, the author throughout made this mistake: He assumed that water gas was, at any rate under most conditions, a *desideratum*. He (Mr. Shadbolt) failed to agree with him. It was an easy matter to confound advantages with claims. Claims were not of necessity advantages; and if they were advantages, it did not of necessity follow that they were so great as might be represented by those interested. Take, for example, what was called the effective control of the coke market. In individual cases, locally, the use of water gas might have a beneficial effect on the coke market from the gas managers' point of view; but he questioned whether this effect could be said to extend universally or generally. For instance, the author

stated (and correctly, he believed) that about 30,000 cubic feet of water gas might be made from 10 cwt. of coke. Taking this as the basis, and taking the maximum capacity of the water-gas plant in use in the United Kingdom at the time the Committee sat, and if, instead of saying that if the plant were worked to its full capacity every day in the year it would produce an amount of gas equal to about 24 per cent. of the illuminating gas supplied, they brought it down to its normal use by dividing it by one-half, they would get 12 per cent. of the total gas made, according to the Board of Trade returns, instead of 24 per cent. If they commenced at this figure, and took 10 cwt. of coke as being capable of generating 30,000 cubic feet of water gas, and assumed that an average limit of one-third of water gas would be imposed, then they arrived at this: That from a ton of coal they made 10,000 cubic feet of coal gas, and added to it 5000 cubic feet of water gas; and in doing this they used 1·66 cwt. of coke. If they followed this up and applied it generally, as represented by the Board of Trade returns, they brought it to this: 1·66 cwt. of coke, multiplied by the 12 per cent. of the total make, and divided by 33·33 (the one-third of water gas), equalled 0·57 cwt. That was what it practically amounted to; and it showed the difference between claims and advantages. They claimed to have an effective control of the coke market; but all they took off the market was 0·57 cwt. of the coke made per ton of coal carbonized, or 6·36 per cent. of the total coke produced. Or if they went further still, and accounted for the coke unmade through less coal being used, and taking the maximum plant that might be said to be in use in the country if fully employed under normal conditions, they then only reached the figure of 18 per cent. of the total coke made. Then it must be remembered that, if they took off the market 18 per cent. of coke which represented a certain gross quantity, someone else would put on its equivalent in coke, coal, or something else; so that they would not be conserving the world's fuel. There was thus a great difference between a claim and an actual advantage. Then, again, as to the benefits to be derived from water gas in the event of a dispute in the coal trade. If they were going to be limited to a certain percentage of carbonic oxide, they certainly would not put down a plant equal to the maximum output of gas; they would only put down a plant capable of dealing with the proportion to which they were limited. Supposing a coal strike took place similar to that to which Mr. Carter had referred, and which was going on rom

this period of the year right into November, when they were nearly at their maximum make—however much at such a time they would like to convert their coke into water gas, the plant provided for the limited make would not be adequate. There would, of course, be a certain advantage, but not so great as originally appeared. Then coming to the saving in the consumption of coal, which Mr. Carter put at 2½ million tons a year. This on the face of it looked a big item. It certainly was a factor, but not of prime importance. To show how these important factors dwindled down when placed under the microscope, he would take the figures given by Mr. Carter, and the statement of Mr. Forster Brown (whose authority on this matter one might assume to be unquestionable) that the vast coalfield referred to, under present conditions of working, had a life of only about fifty years. Then if, by utilizing the water-gas plant in the country at the present day, they saved 2½ million tons of coal a year, it would be found, by working it out, that they would only prolong the life of the coal-bed by 7½ months; so that water gas would not work such a great effect upon the life of the coal-fields. Then there came the question of the cost of water gas which Mr. Carter very properly raised. The cost ought, in his opinion, to be stated right up to the consumers' meters. Here he could not help referring, in passing, to the evidence given by Mr. Isaac Carr before the Water Gas Committee. Mr. Carr was intimately connected with the supply of cheap gas; and, in his evidence, he said that no gas authority selling gas below 2s. per 1000 cubic feet made water gas, and no gas authority in England making water gas—leaving Belfast altogether out of the running—had, since the adoption of that gas, reduced the price owing to economies effected by its use. The question, as the author rightly said, was largely one of locality; and he might have added of scope likewise, because there were very few gas managers in the Eastern Counties who had sufficient scope for the successful application of water-gas plant, however desirous they might be to adopt it, even if it had all the advantages claimed for it, which he contended was open to question.

Mr. W. D. CHILD (Romford) said he was of opinion that the discussion was something like the recent inquiry—a thing that was hardly desirable; and that it would have been better to "let a sleeping dog lie." He did not join with the author in what might be termed the censure which he had put upon the authorities who had control of the capital expenditure of gas companies, such as the Board of Trade and the Committees who dealt with these subjects in Parliament. He believed that these gentlemen

were so thoroughly conversant with, and so attentive to, their duty of safeguarding the public, that they would have come forward voluntarily and introduced legislation on their behalf had they believed there was the slightest necessity for doing so. He thought there was a party in the country who from an interest perhaps other than a desire to safeguard the public would lose no opportunity of pointing to the disadvantages and dangers that were likely to accrue from the use of carburetted water gas. He therefore considered they might safely rely upon it that those who had the control and the granting of powers to gas companies to put down plant of different kinds, when they saw the necessity, or thought it desirable, to interfere, would do so without being asked. He believed there were advantages to be gained by the use of carburetted water-gas plant that the public would share in; and that the time would come, and very shortly, when some of those who adopted it would be able to decrease the price of gas. Then the public would not join in the cry which had been raised to hinder the introduction of carburetted water gas, but would rather join in promoting any process by which they could be cheaply served with a good and useful supply. He did not propose to discuss the paper; and he did not think Mr. Carter intended that the question of water-gas manufacture should be discussed. The author was pointing to something altogether different—that was, as to the desirability of its introduction at all.

Mr. E. H. STEVENSON, on the invitation of the President, said he had a perfectly open mind on the question of water gas. He might say that he had only twice recommended it; and only one of his clients had put it in. In that case, they did not use the plant in the summer time; and the reason they gave for this was that they could not make gas by it as cheaply as they could coal gas. He could only tell the members this as a fact; and as a fact, it only bore out what was his theory—that he did not expect they would effect any saving, that the gas would probably cost them a little more, but that, in the peculiar circumstances of the place, it would save them spending a very large sum for, it might be, five or ten years. It meant an expenditure upon water-gas plant of £10,000, or upon new gas-works of about £130,000. They spent £10,000 or so, and now they were going to expend £130,000; so that really they had not saved anything. If gas manufacturers were going to be limited in the quantity of water gas they could send out to the public, it would be of no assistance whatever, because in the time of a strike they could not put more than 12 or 20 per cent. of water gas in

the supply without being hauled up and fined. And, therefore, it would pay better to run short as in the ordinary way, or buy coal at an enhanced price. Consequently, he did not see in what way (except it might be for enriching purposes on large works) water-gas plant was going to be of even as much use in the future as in the past. Of course, at present they were unlimited in the amount of water gas they could turn out. He knew of one company who were making water gas to the extent of 50 per cent. of their total output; but he did not see the price they charged was any lower than in the surrounding companies' districts, or that the price had been lowered more quickly than in the case of the others. He was quite certain, if gas manufacturers were limited to 12 per cent., water-gas plant would not be seen even as generally in the future as it was to-day. This was his firm conviction; and he certainly should not, until the question of limitation was quite settled, advise anybody to put in this plant. Otherwise they might put it in of much too large a size for future use; and unless they could turn out a large amount of water gas a day, it would not pay, because the great saving which was always claimed for water gas was not in the cost of the oil (because oil was rather dear)—it was that one man could produce 100,000 or 500,000 cubic feet of gas per day, according to the size of his machine, instead of perhaps 30,000 or 40,000 cubic feet by other means. This was why it was claimed that there was a great saving by water gas. Otherwise it was more costly; and if they were limited, and could only turn out a small quantity of water gas, the wages would come much higher than where coal gas alone was made.

Mr. ROBERT PORTER (Elland), called upon by the President, said he could add nothing to the discussion, or place any views before the meeting that he had not already made public. It might be remembered that two years ago he had something to say on this matter in his presidential address to the Manchester District Institution of Gas Engineers; and he did not know that he had learnt anything from the discussion or the paper to alter his views. Mr. Shadbolt had dealt with the general question, although they were told it was not intended that the subject of Carburetted Water Gas *v.* Coal Gas should be discussed on this occasion. But as Mr. Shadbolt had "incidentally" referred to many matters, and Mr. Stevenson had given his testimony that carburetted water gas could not possibly be made cheaper than coal gas, he (Mr. Porter) thought that they ought to ask Mr. Carter to qualify something which he said towards the end of the paper in reference to the cost. He distinctly told them that

carburetted water gas could be made at a considerably lower cost than coal gas; but he did not seem to adduce anything in evidence. He did not show them where carburetted water gas was produced even as cheaply as coal gas. He (the speaker) ventured in his address to place before the members of the Manchester Institution and the gas world some particulars as to the cost of coal gas and carburetted water gas; and the figures had not yet been challenged. Something had been said about the price of oil; but up to the present no evidence had been forthcoming that carburetted water gas could be made as cheaply as coal gas. And he still did not think it could be.

Mr. J. A. NORCROSS (of Messrs. Humphreys and Glasgow) remarked that so much had been said upon the subject of carburetted water gas that it seemed almost impossible to say anything new; but the author of the paper had furnished them with food for a good many hours of solid thought in the novel treatment he had given to the subject, and the many new points he had brought out. There was, however, one assumption in the paper which he did not think ought to be accepted without a great deal of reserve; and the same assumption had been made by Mr. Shadbolt and other gentlemen who had spoken on the subject. He referred to the limitation of the proportion of carburetted water gas during the nightly sleeping period. This problem must in each instance be treated in accordance with local conditions. Mr. Carter had done this, and found the limitation quite practicable in his case. He (Mr. Norcross) would venture to point out, however, that his circumstances differed in many respects from those obtaining in general. For instance, his storage facilities were ample, and his day consumption was larger than the night consumption. While at Lincoln and some other places, "limitation" could be accomplished without serious difficulty, there were in general certain objections which weighed very heavily against such a course; and especially was this so in large centres of population. First, there was the difference existing between the specific gravity of carburetted water gas and coal gas. The latter, being only about two-thirds the density of the former, presented an insuperable objection to delivering the respective gases unmixed during different periods of the twenty-four hours. This difficulty was, of course, proportionately lessened as the one gas was mixed with the other. But it was exceedingly hard to express definitely the variation of mixture that could be undertaken daily without objectionable results. He could at least say that such a variation must not exceed the equivalent of change from pure

coal gas or carburetted water gas to a mixture containing 33 per cent. of the other gas. The difficulty due to specific gravity was, however, augmented by the difference in composition of the gases requiring a different admixture of air for perfect combustion. In view of the fact that the use of gas for heat and power was meeting with such wide application, this point should not be under-estimated. Secondly, it was evident that the proposed system would interfere with the use of carburetted water gas as an enricher of lean coal gas. This enrichment up to parliamentary standard was formerly effected by cannel at an additional manufacturing cost of about 2d. per candle; whereas by the use of carburetted water gas the former expense of enrichment had, in many cases, become a considerable *minus* quantity. Thirdly, the emergency value of the plant would be seriously crippled. Not only would capital investment be profitless during the "limited" period, but extra storage, &c., would be required. Fourthly, the limitation should only apply to the mixture leaving the holders; the gas management could not control the change of mixture throughout the distributing system. Trunk lines would, of course, clear themselves quickly; but gas leaving the holders during periods of light consumption would be several hours before reaching remote districts and dead-ends. Fifthly, a nightly limited period would be practical, *if at all*, only between the hours of 12 p.m. and 5 a.m. The operations of manufacture could not be suspended until the remaining productive power had well overtaken the consumption; and the plant would have to be brought into service again in advance of the heavy morning consumption by mills, &c. Sixthly, apparently sixteen was the highest percentage of carbon monoxide under consideration for the "limited" period. When he (Mr. Norcross) pointed out that the admixture of only 50 per cent. of carburetted water gas necessitated, as a rule, 20 per cent. of carbonic oxide in the mixture, the extent of the limitation appeared very serious. Seventhly, the pronounced tendency of gas administration in large centres of population was to concentrate all manufacturing operations in the suburban districts affording best facilities for space, labour, economical receipt of supplies, shipment of residuals, &c., and to send this gas, as produced, through independent high-pressure connections to the various distributing stations throughout the town. These distributing stations were located so as to preserve a practically constant pressure at the consumers' meters. In such cases any periodical limitation must certainly in practice prove a continual limitation. In small gas-works possessing ample storage

facilities, the operation of a "limited" system appeared feasible; but, even in such instances, he believed that it would finally be deemed entirely unnecessary. As a sign of the times, he mentioned that American extensions in carburetted water gas for the year 1898 amounted to 17 per cent. of the entire output of artificial illuminating gas in the United States; being threefold the extensions of any previous year. About 6 per cent. would cover the increased consumption during the year; consequently, the remaining 11 per cent. represented further displacement of coal gas by carburetted water gas. There seemed no uncertainty in this attitude.

Mr. C. W. GRIMWOOD (Sudbury) inquired if carburetted water gas plant was applicable to small works.

Mr. B. B. WALLER (of the Economical Gas Apparatus Construction Company) observed that Mr. Carter had examined the report of the Water-Gas Committee so very ably that there was little for him (the speaker) to comment upon. He thought some of the speakers had rather drifted from the idea of the paper in that they had brought in the question of cost; and he was inclined to think that Mr. Carter did not intend to actually deal with this point in the discussion, though, of course, it was a very important one. At the same time, he did not himself propose to touch upon it, beyond saying that he agreed with one gentleman that the cost rested almost entirely upon local conditions. In some places, carburetted water gas could be made cheaper than coal gas, and in others it could not be. It depended entirely upon local circumstances. He thought the most important point to be considered with reference to the subject of the paper —the Home Office report—was whether it was in accordance with gas engineers' ideas, and whether it should be adopted in the form in which it had been submitted. Personally, his own opinion was that it should not be adopted in that form. He thought that engineers and others who had control of gas undertakings in this country should have sufficient authority, as they had sufficient consciousness, to provide what they considered right for their consumers. It was not a question of cost; that being a matter to be considered by each individual undertaking so far as their finances were concerned. As to the advisability of the supply of water gas being entrusted to those who had the governing of the gas undertakings of this country, the welfare of the consumers was their first consideration; and it was their own welfare as well. It was therefore hardly likely, in their own interests, that they would take up a process which would be prejudicial to and jeopardize their consumers. He thought

in this respect he rather differed from Mr. Carter in the latter part of his paper—that the restrictions were such as they would generally agree to. With regard to this point, it was mentioned before the Home Office Committee that the danger increased in much greater ratio than the proportion of carbon monoxide. Was not this rather theoretical? It was not what practical experience had led them to believe. If he remembered rightly, it was Dr. Haldane who propounded a theory on these lines, which he placed before the Committee. The question was: Had they any proof of the statement in this country? He did not think they need go to America for any actual proof. Carburetted water gas had been in use in this country for ten years; and this surely was long enough for them to ascertain definitely whether the danger did extend in an increasing ratio. He did not think they had any proof whatever that the danger from the use of carburetted water gas in this country since it was introduced something like ten years ago had increased one jot. With regard to the effects of carburetted water gas on the human frame, either as a deadly or a cumulative poison, he could give a very good example, and that was Mr. Merrifield. A better specimen of humanity he had never seen. No man had spent more hours than he had on the operating floor of a carburetted water-gas plant; and he certainly did not bear out the cumulative poisoning theory, nor did he present evidence of any detrimental effect on his blood corpuscles. If there had been any, he kept it well in the background, and did not make any show of it at all. (Laughter.) He (Mr. Waller) thought Mr. Carter had introduced his paper at a very opportune time, seeing the question of carburetted water gas was being weighed in the balance, and, to all appearances at the present time, it was going to be found wanting to a greater or less extent. Those engineers who were not in favour of water gas need not take any interest in it; but to those who were in favour of it, he thought it was worth their best endeavours to see that legislation was not carried out on the lines of the limitation to 12 per cent. of carbon monoxide. The utility of a water-gas plant was most apparent in the few weeks of maximum demand; and engineers had to maintain their works to meet this maximum demand. If they could get auxiliary water-gas plant put in at about one-third the cost of coal-gas plant for use in the few weeks of maximum requirements, this would represent a considerable saving of capital, and would be exceedingly useful. During the time of maximum demand, he did not think there should be any restriction either night or day in the amount of carbon monoxide. (Laughter.) He

was pleased to hear that the members generally agreed with his view on this point.

Mr. CARTER, replying to the discussion, said he must express his satisfaction upon the freedom with which his production had been discussed. He was one of those who considered it was the finest compliment they could pay the author of a paper to discuss it with all the candour, freedom, and ability one could command. It was quite another thing whether the reply would be equal in capacity to the criticism. He was between two fires. He had first to defend himself against the criticisms of those who seemed to be dead against carburetted water gas—stock, lock, and barrel; and, on the other hand, against the criticisms of those who did not see any necessity for the slightest restriction either day or night. He was also placed in the unfortunate position of having to reply to criticisms which were offered in a very "incidental" way, but which extended to the second place of decimals. Mr. Shadbolt said the title of a paper should indicate something of its character; and he (Mr. Carter) thought those present were entitled to voice that criticism. To tell the truth, he did not know what title to give it. After having carefully, and as studiously as he could, considered, for two or three years, the question of carburetted water gas with the object of putting down an installation in Lincoln, their action had been stayed by the promised inquiry—promised long before it was instituted. So it seemed only natural to await the result of the inquiry; and he had written the paper from the point of view of one who read the report of the inquiry with the greatest care for the determination of two things: On the one hand, whether anything transpired in the course of the investigation which would diminish the value of the supposed advantages which had been claimed for water gas; and, on the other, whether anything occurred in its course which would so magnify the dangers that were said to be connected with water gas as to lead one to give up the idea altogether. Now he thought if members would put themselves, or try to put themselves, in his position when he sat down to write the paper, probably some of the criticisms would answer themselves. Mr. Shadbolt had made two or three statements on two or three different points, which he thought all converged to the same end—that what he (Mr. Carter) stated with regard to the control of the coke market and as to the saving in the consumption of coal by the introduction of carburetted water gas, really both resolved themselves into fractional matters in the result. But, in his opinion, Mr. Shadbolt made this cardinal mistake which was present to his (Mr. Carter's) mind

when he set the figures down. Mr. Shadbolt, in his remarks, assumed that the producing power of the carburetted water-gas plant that was in actual operation in the country a year before the investigation took place represented the maximum amount that was being produced to-day. He (the speaker) took it, having regard to the large yearly increase in the number of installations, that, if he based his calculations on the plants in active operation at the time the Committee sat, he should not be over-stating the case; and, in view of the rapid yearly increase, his figures would be under-estimated rather than in excess of the case. The decimal figures might be wrong after all as a matter of calculation; and what he (Mr. Carter) had said with regard to the quantity of coke taken off the market and the quantity of coal saved, might be, and was very likely at the present moment, far below the amount of advantage that gas manufacturers were reaping from the introduction of carburetted water gas. He still asserted that the manufacture of that gas had produced a revolution in the coke trade; and he would ask the members not to imagine, because they had the present spurt of industrial prosperity (with which they were all so well satisfied and highly pleased), that to this alone was due the better prices they were able to make for their products at the present time. They might depend upon it that the manufacture of carburetted water gas had had a great deal to do with the abstraction from some of the Provincial markets of the surplus coke from the London gas-works. With regard to the cost of the carburetted water gas, he only mentioned it incidentally. He should not have referred to it at all, but it occurred in the course of the inquiry; and, even in the most discursive study of the report such a subject as that could not avoid notice. He presumed all present had observed that their friend from Grantham was tightly cornered upon this matter when he wished to impress on them that coal gas could be made cheaper than carburetted water gas. He was reduced to confining himself to one authority; but he (Mr. Carter) was not going to say anything derogatory of that friend, who occupied a position of splendid isolation. He made cheap coal gas, and sold cheap gas; and he was entitled to all the credit of his accomplishment. But there were a dozen others who were ready to say, and did say, that they made carburetted water gas cheaper than they did coal gas; and the statement published in the report—the statement of Mr. Isaac Carr, to which Mr. Shadbolt had alluded—was completely contradicted by subsequent witnesses, who said, so far from the statement being true that since the introduction of

water gas no reduction had taken place in the selling price of gas, in one case the price had been reduced twice. Apart from this, he (Mr. Carter) wanted them to observe this point also, that Mr. Carr was very careful in wording his statement. He did not say that no reduction had been made in the selling price because carburetted water gas had been introduced. No connection was sought to be established between the two things at all. He was prepared at present—until Mr. Shadbolt favoured them with a paper (the subject would suffice for a very interesting contribution at some future meeting of the Association) giving figures very different from those he (Mr. Carter) had been able to see as the result of inquiry—to stand by the statement he had made in the paper, that at the majority of gas-works in the United Kingdom carburetted water gas could be produced more cheaply than coal gas. He did not wish to censure any public authority. His humility would always prevent him from any attempt of that sort. But it did appear to him that the attitude of the authorities was unreasonable. To stand absolutely in the way for two or three years—without consenting or without disapproving—of any movement in this direction, pending an inquiry which they were so slow to institute, naturally would create a good deal of irritation. Regarding the remark of Mr. Stevenson that the limit of 12 per cent. would seriously diminish the utility of the carburetted water-gas plant, he (Mr. Carter) did not quite understand whether his idea was that the limit was going to be 12 per cent. of carburetted water gas.

Mr. STEVENSON: I had that in my mind at the moment. I admit I was wrong.

Mr. CARTER (proceeding) said the suggestion of the Committee was that the proportion of carburetted water gas should be limited to such an extent that, in the mixed gas at night time, there should not be more than 12 per cent. of carbonic oxide, which would mean an admixture of 25 per cent. of carburetted water gas even during sleeping hours. But the point of greatest importance was this: The Committee had told them that in the daytime the proportion of carbonic oxide, or the proportion of carburetted water gas, was not of very serious consequence. Judging from the report, they would be allowed to supply as much as they liked of carburetted water gas during the day. Putting on a modest limit, they could go up to 40 or 50 per cent. during the day, and have 25 per cent. during the night. What was the effect of this on the twenty-four hours' consumption? They would be allowed—after a report like this, and after such an investigation—to supply water gas to the

extent of from 30 to 33 per cent. of the total twenty-four hours' consumption. This brought him to the conclusion that this was a quantity sufficient to render carburetted water-gas plant of the highest utility to the gas-works of the United Kingdom. He had now to defend himself from those who saw no reason for limitation at all. It certainly did seem to him that it was a matter of the first necessity for the Committee to take some note of the prejudices which had been created—wrongly created, if they liked. They had to reckon with and face the prejudices which existed in the public mind against the supply of carburetted water gas. It seemed to him that the Committee, in the suggestions contained in their recommendations, had taken a safe middle course. While they had had regard to the public safety, on the other hand they had evidently decided fairly as to the quantity of carburetted water gas that could be sent out from the works. As to the difficulties which Mr. Norcross suggested—difficulties in distribution arising from the differences in the specific gravity of the two gases, he (Mr. Carter) had been informed by those who were supplying the two gases that any little difficulty they had experienced was easily overcome by a slight adjustment of the initial pressure at the works. With regard to the difference in the densities of the two gases, it had been shown that a reasonable percentage of the water gas—say, up to 33⅓ per cent. of the total—caused no difficulties either with ordinary burners or with gas ovens and fires; and in this matter he thought that they were justified in taking experience as their guide. As to Mr. Grimwood's question, until carburetted water-gas plant was constructed of very much smaller capacity than they had yet heard of, it did not seem at present that it would be useful on small works. But on works making (he was going to say) a million cubic feet a day down to works producing 400,000 or 500,000 feet a day in midwinter, his opinion was that there was a useful scope for carburetted water-gas plant. Whatever their opinions might be that day, he thought it was a most probable thing that, in the course of the next five or ten years, they would see in this country scarcely a large works—and he might venture to say not many medium-sized ones—without the advantage of a carburetted water-gas plant.

The PRESIDENT remarked that they had had an able paper and an excellent discussion and reply; and he would ask that a hearty vote of thanks be given to Mr. Carter for his splendid contribution to the proceedings.

Mr. CARTER briefly acknowledged the vote

Place of Next Meeting.

The Committee recommended that Cambridge should again be selected for the spring meeting in 1900, as it appeared the most centrally situated town.

The suggestion was approved.

The thanks of the members having been accorded to the County Council for the use of the Town Hall, the business proceedings terminated.

Owing to the inclemency of the weather, a drive, which had been arranged by the President, had to be abandoned.

The day was brought to a close by a dinner at the Bristol Arms Hotel; the members being honoured by the presence of the Chairman and Directors of the Gas Company, and the President of the Gas Institute. The customary toasts followed.

Several of the visitors remained over the following day; and full amends were made for any disappointment felt by them at the loss of the drive on Wednesday. The weather was in striking contrast to that of the preceding day, being simply beautiful; and a drive of about 16 miles was indulged in. Altogether, the party numbered 24. The route taken was through the villages of Kirkby-la-Thorpe, Heckington (the Queen of Lincolnshire villages), Howell, and Ewerby; thence through Haverholme Park, the seat of the Countess of Winchilsea—viewing the gardens, the priory, the deer in the park, and the river—and back to the Bristol Arms Hotel for luncheon, recreation, and tea. The party left Sleaford about seven p.m.; expressing, before their departure, their great appreciation of the liberal entertainment provided for them during the visit by the President and his Directors.

NORTH OF ENGLAND ASSOCIATION

HALF-YEARLY MEETING, OCT. 7.

This Meeting was held in Newcastle; and the attendance was the largest ever experienced at a meeting of the Association.

Visit to the Gas-Works.

The members met at the office of the Newcastle and Gateshead Gas Company, in Grainger Street, shortly after eleven o'clock, and were driven to the Redheugh Gas-Works of the Company, on the Gateshead side of the Tyne. The President of the Association (Mr. W. Doig Gibb, Engineer to the Company) was in charge of the arrangements for showing the visitors over the works, and was assisted by the Works Manager, Mr. T. Hardie. It was explained that the works consisted of two portions—old and new—and that it was the new part which was to be shown. There are two retort-houses in the new portion, built of brick, of elegant architectural design, and substantial. An elevated railway runs along each side of the houses, giving ample storage room for coal below. The house which was visited is 300 feet long and 100 feet wide. In it there are two retort-benches, on end, each containing twelve ovens. There are nine retorts, through, ⊓ shaped, 16 in. by 22 in., and 20 feet long, in each oven. There is a chimney, of handsome design, 120 feet high, at each end of the house. The house is ventilated by three large towers, each 6 feet in diameter, and by smaller smoke-boxes, in the roof. The firing is by a regenerative system arranged by Mr. Hardie. To each bench there is, on both sides, a coal breaker and elevator, all of which are driven by a separate steam-engine. The charging and drawing are done by West's machines, worked by compressed air. The compressors (Messrs. West and Jenkins's patent) are in a separate building, which runs at right angles to the retort-house, and in which are also the boiler-house, the exhausters, and the station meters. There are two compressing machines. They are driven by steam-engines, which are designed to work according to the pressure in the receiving tank; taking steam automatically as they require

it. The maximum pressure is 70 lbs. per square inch. Steam for this section of the works is provided by four Lancashire boilers, fitted with Meldrum's patent furnaces. There are two exhausters completed, one of 175,000 and the other of 150,000 cubic feet capacity; a third being in course of construction. Two have been fitted up by Messrs. Bryan Donkin and Co., Limited, and one by Messrs. George Waller and Co. One station meter has been completed (of 175,000 cubic feet capacity) by the Gas-Meter Company, Limited; and the visitors had the rare fortune to see a second one in process of erection—the drum actually in position, with the ends open. Behind this house are two sections of horizontal condensers, and two series of tower scrubbers (six in each), built by the Whessoe Foundry Company, Limited. To the west of these is the purifier-house, in which there are twelve boxes, each 32-feet square, with four trays, requiring 25 tons of lime. The Contractors were the Whessoe Foundry Company and Messrs. Ashmore, Benson, Pease, & Co., Limited. Further west is the sulphate-house, fitted with plant by Mr. Maurice Schwab. A feature of the process is the extraction of the arsenic from the acid by means of the waste gases from the saturator, which leaves extremely white crystals. There is also a closed sulphur-recovery box, on the Claus system, erected by Messrs. C. & W. Walker, Limited. This is at the extreme western boundary of the site, where a gut runs up from the Tyne, by means of which the sulphate is taken away in barges. The gasholders are to the south. The space is fully occupied, which has led to the laying of a main to the site of the new works at St. Anthony's, four miles lower down the banks of the Tyne, where a large new holder has been erected, and into which gas is to be pumped from Redheugh. For the pumping, two of the largest exhausters ever built, each capable of passing 300,000 cubic feet of gas per hour, have been provided. They are driven by gas-engines of 25-horse power. This section of the works, which is capable of an output of 3 million cubic feet of gas per day, has been completed this year. The design was prepared by the late Mr. V. Wyatt, the Consulting Engineer to the Company; but the details were arranged by Mr. Gibb, the present Engineer. As explained by him in his paper read before the Association last April,* the gas is sent across the Tyne to a new governor-house which he has erected in Brunel Street, near to the Elswick works of the Company, and from which it is distributed. In his paper, Mr. Gibb fully described the plant in the house, which consists of a series of governors by Messrs.

* See *ante*, p. 106.

W. & B. Cowan, Limited, pressure-registers by Messrs. James Milne and Son, Limited, pressure-gauges by Messrs. Alder and Mackay, and the ingenious syphon pump arrangement planned by Mr. Gibb, and constructed by Messrs. R. Laidlaw and Son—all of Edinburgh. On the termination of the tour through the Redheugh works, the company were entertained to light refreshments in the house, close by the gate, which was long occupied by the late station manager. On the return drive they called at the new governor-house, and spent some time in an admiring survey of it. The works were seen in their every-day aspect, no attempt at garnishing having been made.

The Meeting.

The formal business meeting was held at the office of the Gas Company—Mr. Gibb presiding.

New Members.

The following were admitted to the Association :—

Ordinary Members.—Fawcett, A. C., Blyth; Golightly, I. H., West Stanley; Henderson, G., Redheugh; Hutchinson, E., Goole; Lewis, J., Newcastle; Nelson, R., Hexham; Templeton, J., Leeds.

Associate Members.—Atkinson, R. L., Newcastle; Thomas, H. (Messrs. Bryan Donkin and Co.), Manchester.

The Workmen's Compensation Act.

The Hon. Secretary (Mr. J. H. Penney, of South Shields) read the following report upon the scheme of insurance under the Workmen's Compensation Act:—

"It will be remembered that at the last half-yearly meeting of this Association, held in April, I submitted a report indicating that the Insurance Corporation with whom we are insured had only agreed to make an abatement in the premium of 6d. per cent.—namely, from 9s. 6d. to 9s.—which the Committee did not consider satisfactory. However, as the period approached for renewal of the policies, there were rumours that the rate was coming down; and the Insurance Corporation were again approached with the view to a more substantial reduction. In the meantime a circular was sent out from this Association, to gas companies in the North of England, on the 23rd of June last, asking if a lower rate had been quoted to them. The replies indicated that this was the case—thus confirming the rumour. This information having been brought before the notice of the Insurance Corporation, they ultimately met the Committee by reducing the premium from 9s. 6d. to 5s.

per cent. This was communicated to the gas companies in the district by special circular on the 1st of July last; and the result has been that most of the gas companies in the North have renewed their policies at the reduced rate, and, with but few exceptions, have expressed their entire satisfaction with the concession. Gas companies in various parts of the kingdom have also taken advantage of this arrangement by insuring. The Committee trust the members of the Association are satisfied with what has been done in the matter."

The PRESIDENT said the Association were much indebted to Mr. Penney for what he had done in connection with the subject.

JUBILEE CONGRATULATIONS.

The PRESIDENT said he was sure that no one would grudge a few moments—though their time was short—in combining to congratulate Mr. J. H. Cox on having celebrated the jubilee of honourable and onerous service with the Sunderland Gas Company. He regretted, for a moment, that he could not recall the moment when Mr. Cox first joined the Company. He could not even remember the time when he assisted in forming their Association, which was now so prosperous. But he did know that since he came to the district he had found in Mr. Cox a warm and kind-hearted friend, and one who was always willing to extend the benefit of his large experience to those who were not fortunate enough to be in so happy a position as he himself was. They all rejoiced, of course, that his Directors had seen fit to recognize the merits of so faithful a servant. He thought that they also rejoiced that the shareholders had, for once, done better than the Directors in appreciating Mr. Cox's merits. He begged to move—"That this Association heartily congratulate Mr. J. H. Cox on his completing fifty years' service with the Sunderland Gas Company, and also the spontaneous recognition of his merits by both Directors and shareholders."

Mr. E. H. MILLARD (Durham) said it afforded him great pleasure to second the motion. He, fortunately, could remember, some considerable time back, when he was in the North, the work which Mr. Cox did in connection with the Association. He had now returned to his first love, as he might term it, coming to the North again; and he regretted that they had not had quite so much of Mr. Cox's presence as they would have liked. There were a good many of the old ones now who seemed to think it was time they gave place to the younger. But the younger liked to see their older brethren present, to keep them right when they went wrong.

Mr. W. FORD (Stockton) said they were in rather a peculiar position; one of their original members having attained fifty years' service under a Company he had served faithfully and well. He would suggest that the resolution should be engrossed, in illuminated style, on vellum, and forwarded to Mr. Cox.

Mr. T. BOWER (West Hartlepool) expressed his great pleasure in seconding the proposal. He said it would be noted by some of the members that Mr. Sellers, of York, had also this year attained his jubilee; and he thought it would be very fitting that they should include his name in the resolution, and send it to him in the same way. Mr. Sellers had, in the past, done much for the Association.

The PRESIDENT cordially agreed to Mr. Bower's suggestion; and the resolution was adopted.

It was left to the President and Secretary to arrange for the presentation of the illuminated copies.

PROPOSED CHANGE OF RULE.

The PRESIDENT gave notice that at the next meeting he would propose—"That persons not under eighteen years of age, holding responsible positions in gas undertakings, and pupils of gas engineers, having the object or intention of becoming gas engineers and managers, be eligible for election as members; and that the rules of the Association be altered accordingly." He said the elaboration of the reasons for this proposal would fall to take place at their next meeting, in accordance with the rules; and meanwhile members could be studying the subject.

THE PRESIDENT'S ADDRESS.

The PRESIDENT then delivered the following

INAUGURAL ADDRESS.

Gentlemen,—My occupation of the presidential chair this morning makes me feel a deep sense of the honour you have conferred upon me. The honour is the greater seeing that the Association is in such a flourishing condition. I trust that during my year of office no microbe of discontent or inanition will find opportunity to make a beginning of the decay that so often proves the beginning of the end.

To those who take pride in the growth of our Association, it must be gratifying to note the continued prosperity of the gas industry generally. This prosperity is at present being maintained against keener competition than in former years; and everything goes to prove that the struggle in the future will be even more severe than it has been in the past. It therefore

becomes more than ever necessary that the men who are to occupy responsible positions in gas undertakings should be those who, by reason of their general and special education, are best qualified to carry out economically and skilfully the work which they may be called upon to perform. Where are such men, when required, to be got? Echo answers, "Where?" This country is only now slowly wakening up to the fact that in all directions, and in almost every business, foreigners are beating us—and why? Because in many cases Britain's sons are content to be as their fathers were before them, and soothe themselves with the old commonplace: "What was good enough for our fathers is good enough for us."

Fortunately, all are not so slothfully disposed; and an abundance of schools and colleges for general and technical education now invite the younger generation to acquire that intellectual supremacy which will go far towards completely arming them for the future battle of life. I have already said the country is only slowly wakening up; and I am afraid that I must add that those intending to adopt gas engineering as a profession seem to have been the soundest sleepers of all. Whether this is due to the fact that the gas industry can only be indirectly affected by outside competition, or because, as has been pointed out in the *Journal of Gas Lighting*, many companies require such a low standard of qualification in their employees, or because students do not know what particular lines of study to follow out, the result, at all events, is to be deplored. The latter cause is a real one; and I therefore purpose devoting a portion of the short time at my disposal to sketching out what I consider to be suitable training for a youth who aspires to eventually hold a responsible position in a gas undertaking. I do so, however, not believing that my views will meet with general acceptance, but trusting that the free expression of my opinion may lead to criticism and discussion, and by that means hasten the formation of a sound public opinion on this most important subject.

At school, special attention should be paid during the last few years to mathematics. On leaving school, if in good health and of strong physique, what I consider the *sine qua non* of an engineer's training—the serving of a practical apprenticeship in an engineering establishment—should be entered upon; a turn being taken while there in all the shops, and also in the drawing office. On its completion, a year or more can be profitably spent in the erector's yard of a firm who make a speciality of gas plant. While at this work, a chance of getting into a gas-works under a

good engineer should be looked for; the best place perhaps being in the drawing office, with permission to go anywhere to learn the whole working routine of gas making. During this and the preceding period, opportunities will very likely occur for having charge of small bodies of men, and bearing a certain responsibility in the proper carrying out of work. From the time of leaving school, technical classes at a good college should be joined; the best subjects for study being mathematics, plane and solid geometry, theoretical and applied mechanics, machine and building construction, theoretical and practical inorganic chemistry (as well as a little agricultural chemistry), steam, light and heat, electricity, and, of course, the principles of gas manufacture, if this last be available. After a year or two spent in a gas-works, with the practical training received there and elsewhere, and with the theoretical knowledge obtained from classes, an appointment to a responsible position may be confidently looked for. Till this be got, and even afterwards, systematic evening study should not be neglected. From the time of leaving school, this training will occupy from seven to nine years; and for the greater portion of this time little remuneration may be obtained. The finished student has therefore paid a heavy price for his training in hard work and study, and in valuable time expended.

The question naturally arises whether the chances of securing a responsible position, and the salary paid to the holder of it, justifies a youth in selecting gas engineering as his particular business. The question is more easily put than answered. Compared with other branches of engineering, I am inclined to say that it does. Undoubtedly many companies do not pay such salaries as will induce students to thus carefully qualify themselves. But the result to those companies is generally a serious and constant loss through the non-application of scientific skill to their undertakings; though very probably many of these companies are content, for it is not likely that a governing body who cannot recognize the value of specific and high-class training will detect the constant leakage of possible profits thus caused in their undertakings. Nothing short of the sudden disappearance of some official with their funds can rouse such men.

Before leaving this question, it may not be out of place to give a word of warning to the finished student. He must not, even in thought, disparage men belonging to the old school, or even the "rule-of-thumb" men. Both are really his equals; for while the student may have a technical training, and be

steeped full of theories and deductions, the others have experience. This is quite as important a qualification; for it, too, must be acquired by the student before he can be classed as a good all-round man. Even when that happy consummation is reached, it may be well to recollect that some of the older men possibly took more advantage of their very limited opportunities than, relatively speaking, modern students have done with much greater facilities available for self-improvement.

In these days of specializing, while a competent engineer can be found with some knowledge of chemistry, or a competent chemist with some knowledge of engineering, it is rare indeed to find combined in any one man the qualities of a specialist in both. It is therefore necessary, where the size of the works warrants the expenditure, for a good chemist to be kept to help the engineer. With the aid of the information supplied by the former, the engineer may be enabled to design and work plant so as to get the best results from it. In the experimental gas-works, too, the chemist is of the utmost value. In the hands of the engineer, this plant is one of the most valuable pieces of apparatus which can be laid down in a gas-works. Experiments as required can be accurately and cheaply made with its aid; the information necessary for the skilful carbonization of different coals in bulk can be got; the quality of any coal being delivered over a period of time can be checked; the nominal and the mixing values of any enricher can be determined; the action of purifying materials can be ascertained; and, in short, the secrets of coal carbonization generally can be searched after, found, and applied to the works proper. The most convenient size for such an experimental works is perhaps that which has two settings, each containing one single-ended full-sized retort, with other parts of apparatus in proportion. A useful auxiliary to this is a smaller plant with a gas-fired retort designed to deal with 2·24 lbs. of coal at a time. Smaller gas-works could have the advantage of such a plant by either coming to some arrangement with a company who possessed one, or by uniting with other similar-sized works in the same vicinity in maintaining one common to all. It is to be regretted that some recognized method of sampling coals, and one fixed design of apparatus for testing those samples, cannot be arranged and adhered to. When most printed analyses of coals are studied, it is at present hard to say whether the sample of coal tested, or the apparatus by which the results were got, or one's own stupidity in not being able to get such results, should most be blamed; but it is certainly difficult to reconcile the paper results with

those obtained from the coal in bulk. The President of the Institution of Gas Engineers has suggested a way out of the difficulty; and I look to the National Gas Research Laboratory and Works to settle these knotty points.

Our Association has taken such a prominent position in securing for its members and others reasonable terms of insurance against the results of the Workmen's Compensation Act, 1897, that I deem a few words on this subject are necessary. The proposal to combine together was first made by Mr. Thomas Bower; and it says much for this gentlem an's perspicacity when it is recollected how closely his then prophetic remarks have now become accomplished facts. Through a long series of negotiations, our excellent Secretary (Mr. J. H. Penney) has, for a second year in succession, carried the arrangements to a satisfactory conclusion; and to him the warmest thanks of the Association are most undoubtedly due. To secure a 5s. rate in a substantial Company doing an enormous business, is a feather in the cap of the Association; and even though other and smaller companies may now be quoting similar rates, I claim that those lower quotations are in great measure due to the action of this Association, which was the pioneer in the attack on the high rates first quoted. We are only learning as yet the true meaning of the Act itself; and any lengthened reference to it may be profitably left to a future occasion. It undoubtedly extends the responsibility of employers, and improves the position of workmen. In the days gone past, when man and master worked hand in hand, and wages were low, I should have hailed the present Act as a fit and proper one. There is no doubt a moral duty on the part of every employer to see that none of his workmen suffers more than is unavoidable through injuries received while properly following their employment under him. But in the present state of things, when workmen have, by combination and other methods, forced up their wages until many of them stand at too high a rate, the case becomes different. At the present time, employers have little need to have an additional burden put upon them. I believe strongly in compulsory insurance against all accidents, and suggest that some such arrangement as the following would be an improvement on the present Act. Accepting the rates of compensation as at present named in it (though these are not all they might be) to make it compulsory—

1.—For the employer to insure all his workmen who earn 20s. or under per week.

2.—For the employer and the class of his workmen who earn from 20s. to 30s. per week to jointly insure.

3.—For the workmen earning above 30s. per week to insure themselves.

And now to pass on to other subjects. Some three years ago, I had to plan out a new gas-works of considerable size; and the development of this work still occupies a very large portion of my time. I have therefore had to give serious attention to the particular system to be adopted in carrying out the different processes of gas making. It may not be without interest if I devote the remainder of my address to briefly touching on some of the main features of these works as designed.

The site is rough ground, with considerable differences of level on it. It is well situated, having a navigable river as its south boundary, a broad new road running into the centre of the city as the north boundary, and being intersected from east to west by a double line of railway. The plan of the works has been laid down with due regard to economical construction and working, and with ample open spaces between the different erections. The works are in sections, each one in itself constituting a complete gas-works. The retort-houses are placed "end-on" to the railway, though I should have preferred them side by side. The shape of the site, however, prevented this.

The comparative claims of inclined retorts and horizontal retorts charged by power machinery have been long and carefully considered by me. The local conditions may be stated as follows: The works are situated in such a position as renders compulsory, or nearly so, the use of freshly-wrought best North Durham gas coal. With the exception of what is supplied from one or at most two pits, all the coal becomes more or less plastic when heat is applied, and swells so much that the coke becomes firmly bound in one piece in the retorts. A part of the coal is delivered as dust, or something nearly approaching it; and, in consequence, during bad weather it often reaches the works in a very wet state.

I have had opportunities of carefully inspecting many of the installations of inclined retorts throughout the country. Many work well. The charges are run in evenly; no "creeping" takes place; and the coke practically runs out itself when the stop-plates are removed. But in such installations it is to be noticed, when the doors are opened, that there is evidence on the surface of the coke that the coal had not swollen much, or become plastic, during carbonization. Other installations do not work well. The charges are run in evenly; but very considerable "creeping," or, to be more correct, "flowing" takes place. The top parts of the retorts have, in consequence, no

charge in them, and are being uselessly burnt away; while the charges towards the bottom, becoming larger, are often not properly burnt off, and the coke refuses to run when invited to do so. When this happens, there follows work of a very severe nature for the men; and if the benches be only manned for perfect working, considerable delay may take place in the re-charging of the retorts. Where considerable "creeping"—to use the older word—has taken place, it is generally easy to see, from the appearance of the top of the coke, that the mass has been plastic at some time during carbonization.

Attractive, therefore, as the system is, it is one where local conditions must be very carefully taken into account. Though well aware that my views may have to be modified, I am at present of opinion that, while inclined retorts are the best for dealing with hard coal, their working becomes more unsatisfactory the nearer the character of the coal handled approaches that of the gas coal raised in the North Durham district. As a consequence, I feel that I should not now be justified in preferring the inclined system to machine-charged horizontal retorts. But I do not wish to be misunderstood. My advice is to test the coals on which you are dependent; and if sufficient suitable material can be got to prevent at any future time a "ring" of colliery owners being formed against you, and especially if you are not able to keep on sufficient retorts to fully utilize power machinery, then fit up inclined retorts. The system has many advantages and some disadvantages; but, with good engineering, I believe several of the latter may be minimized, if not actually done away with.

The retort-houses will, as I have said, be "end-on" to the railway; and the principal coke-yard will be "end-on" to these as well. The coke may therefore have to be moved some 800 yards—a distance which renders the use of direct lines of conveyors from the retorts to the yard quite unsuitable, even if it were wise to use conveyors for coke at all, which I very much doubt. My original intention, some two years ago, and one which I see no reason to depart from now, was to lay small-gauge rails right through the retort-house vaults on to elevated open centre roadways in the coke-yard, and run service trucks with dropping bottoms over these, either by small locomotives or by wire ropes and stationary engines. The coke would be drawn from the retorts on to iron grids below the upper floor, cooled, and then shot direct into the trucks. Kicking-blocks would be fixed on the railway, so that the coke would be automatically tipped from the service trucks either into railway trucks beneath

or on to any part of the coke-yard as might be required. Sunk docks in the coke-yard will be provided, for ease in filling the railway trucks from stock.

It is proposed to run the railway trucks at the proper level into the coal-stores, so that the coal may be dropped direct into position. As the hoppers into which the coal will be emptied in the usual course will be situated at the sides of the stores, as the stored coal will not perhaps be moved once in a year, and as with any system of conveyors hand feeding to some extent would be required, I do not consider it necessary or expedient to provide any conveying machinery for handling the stored coal. In a general way, the trucks will tip their contents direct into the hoppers of the coal-breakers, in connection with which there will also be emergency hoppers standing full of coal. To provide for any small deficiency in the day's delivery, I contemplate having another form of storage in high capacity steel waggons, each holding from 35 to 45 tons. These can be moved and filled and emptied by the service locomotives and their men without the coal being handled by labourers at all. They may thus be called portable coal-stores.

I believe that the best results in condensation will be got by leading the foul mains round the inside of the retort-houses, and then allowing as long lengths as possible to be buried in the ground before reaching the condensers proper, which will probably be made in two sections for each complete block—one water, the other atmospheric—and these again subdivided, so that any desired gas temperature can be readily obtained.

For the washing and scrubbing of the gas, probably the best arrangement is to have tower scrubbers followed by power-driven scrubbers; tar-extractors being interposed between these and the exhausters. The tar-extractors, if the condensing arrangements be efficient, may not have much to do; but the damaging effect of tar on the scrubbing surfaces proper is so great as to render the use of extractors advisable. The tower scrubbers will be filled with wood sieves made up of thin boards 7 to 9 inches deep and about $\frac{3}{8}$-inch thick, kept apart by strips of similar thickness; the layers of sieves in the scrubbers being "corkscrewed" up so that six or eight tiers are required to complete a circle. By the use of such boards, a much greater area of scrubbing surface is presented to the gas than by the older methods of filling; and there is little or no chance of the gas forming a "run" through the material.

The purifiers will be carried on iron stagings, so that railway trucks can be run below them and the spent lime shot direct

from special doors in the bottom of the purifiers. The roofs of the houses will be supported by iron columns only, so that the purifiers may be amply ventilated. For the comfort of the workmen, and in order to prevent chilling wind playing upon the covers, a series of doors running on outer and inner rails will be fitted in each house between the floor and the roof, to form wind-shields. The lime-floors will be to one side of the purifier-houses, with floors at the level of the top of the purifiers, and will have elevated railways running along one side of them, to allow the lime shell to be deposited from the trucks direct on to the floors.

Taking into account the ultimate length of life in gasholders, the questionable great saving in designing them with lifts above the framing, the storm-swept position they have in this special case to occupy, and the limited knowledge of the ground as derived from borings, I have not felt justified in arranging for any lift (of the first gasholder at least) to project at any time above its framing. At a future meeting, I may have an opportunity of giving you my views more fully on this subject.

Gentlemen, I thank you for your patient attention, and, in conclusion, would point out once more that the deductions I have made, and which I have stated in the latter part of my address, are largely based on local conditions and requirements, and are certainly not applicable over too extended an area. But, at the same time, addressing as I do the North of England Gas Managers' Association, I trust that some part at least of this my maiden address may have been interesting, if not useful.

Mr. S. STEWART (Greenock) said he had very great pleasure in proposing a hearty vote of thanks to the President for his interesting address. It was full of matter which was well worthy of their consideration. When he bore in mind what a busy man their President was, it was astonishing to him that he had had time to produce so excellent an address. He (Mr. Stewart) had the greater pleasure in submitting this motion from the circumstance that he knew the President's father, the Treasurer of the Edinburgh and Leith Gas Commission; and he was glad to see the son of that gentleman making so great a mark in the gas profession.

Mr. A. B. WALKER (Walker) cordially seconded the motion. He said he thought that the President's address was specially interesting to the members, particularly to those who had met Mr. Gibb in a professional capacity, and who knew the sort of man he was.

The PRESIDENT thanked Mr. Stewart and Mr. Walker very much for the kind remarks they had made with regard to his address, which he confessed he had prepared under some difficulties. He waited and waited for some inspiration; but, the inspiration not coming, he had to tackle the matter as best he could. If there was in his address any point of interest to them, he was perfectly satisfied.

Mr. E. H. MILLARD (Durham) read a paper entitled—

ALL SORTS AND CONDITIONS OF GOVERNORS.

I am afraid the title of this paper, so closely resembling that of a popular novel, and my manner of treating part of it, may savour somewhat of frivolity. But, following a holiday season, and this being partly a holiday occasion, I hope that any whose feelings may be thereby outraged will let me down as gently as possible; for I fear I have nothing very *novel* to offer them beyond the title.

I will start with the governor usually first met with in gas manufacture—viz., the exhauster bye-pass governor. Many people are now using gas-engines for exhausting; and I will just point out a useful adjunct I first used under similar circumstances. The speed of the gas-engine being capable of adjustment within very narrow limits, the extreme variations in the hourly makes of gas in summer and winter are met by exchange of speed pulleys; and it is imperative that a portion of the gas should at all times be bye-passed. Of course, the amount the bye-pass throttle-valve should be open varies very considerably; and that useful north country household implement the "wreckin" first gave me my idea for this adjustment.

I have one brass tube sliding within another, and capable of adjustment by means of a pin slipping through holes in each. If one has the holes every $\frac{3}{4}$ inch, and the other every $\frac{1}{4}$ inch, it allows of a very fine adjustment. I am afraid comparatively few beyond the makers fully realize the extra work thrown upon exhausters by this bye-passing. With a vacuum on one side and a back-pressure on the other, making together possibly some 15 to 18 inches pressure, a 1-inch pipe will pass over 5000 cubic feet per hour—a figure which represents half the summer hourly production of the majority here. Hence the importance of having the amount of opening of the throttle-valve readily under control, more especially with the 2-inch or 3-inch valves usually supplied.

With steam-engines, there are now so many excellent governors acting on the steam throttle-valve, that it would be invidious to

mention one by name. To prevent a too hasty action in such governors, and also in station governors, the gas inlet-pipe to he bell is throttled; and I have come across several old governors which have been made to act properly by this means. In one case, the inlet-pipe requiring renewal, the fitter carefully removed the *obstruction*, as he thought. A ready means of adjustment is afforded by screwing the top of the stand-pipe to take an ordinary wrought-iron cap, in the sides of which three or four small holes have been drilled, and which can be partly closed by screwing the cap down on the stand-pipe.

We now come to station governors, the benefits of which we are all of us apt to forget till one has to do without them. Much as I should have liked to trace the evolution of the station governor from its earlier forms to its present state of perfection, the time is all too short. However, I will draw your attention to a very early type of governor, as illustrated in "Peckston," about 1840, especially pointing out the water loading, a subject in which I have long been interested, but which has only come into anything like general use during the last decade. Clegg also gives an illustration of Keeling's method of regulating pressure by water loading, in which a reservoir of water is lifted and lowered by a small winch arrangement fixed to an adjoining wall. The rate of loading is regulated by a valve between the two reservoirs.

All the earlier types of governors were open to the objection that they exposed the bell to the full area of the main, and also that the area of the cone at the base was subjected to the inlet pressure when, with small consumption and a change from a light holder to a heavy one, the valve was jumped, and shut the gas off. The general introduction of telescopic holders aggravated the latter risk; and a disastrous explosion in a London gas-works in 1865 showed the danger of the former.

Inventions to obviate these defects were as thick as blackberries. An entire casing-in of the governor-bell was an idea to correct this danger of explosion; arranging for the inlet gas to operate above the cone, and so rather cause it to open, was a cure for the latter. But unless the area of the bell was sixteen or twenty times that of the valve, the governor was not reliable; and this resulted in governors for large-size mains resembling miniature gasholders, and necessitated the use of excessive weights to give the alterations in pressure needed, besides emphasizing the variation in the flotation required according to whether much or little of the bell was under water.

There is little doubt that this delayed the adoption of water

loading, especially with non-compensating governors, as the quantity of water required cost by no means a small sum, and the time necessary to run the water on and off was too great. Others in the field with improvements on governors in the early seventies were Messrs. Hunt, Warner, and Key, with their equilibrium governors. Mr. Methven, in 1872 (British Association meeting), described a method of water loading. Mr. Laidlaw, at the following meeting, described an exhauster bye-pass and governor in which was introduced for the first time an internal compensating chamber with the same area as the valve. This, however, was not patented.

The Braddock station governor, with the compensating chamber inside the bell, was introduced about 1876; and Messrs. Laidlaw afterwards made a similar station governor. With this type, the area of the compensating chamber is constant; but the area of the parabolic valve exposed to the inlet pressure varies according to its position with respect to the seating, so there is not perfect equilibrium in all positions. About the year 1882, Messrs. W. & B. Cowan introduced their governor with the compensating chamber on the top of the bell, which many of us have cause to be thankful for, as it enabled us to make old-pattern governors efficient at a small cost. They also used the parallel valve about the same time. Other makers more recently in the field are Messrs. Parkinson with their double parabolic valves, and Messrs. Willey with their open-end cylindrical valve—the object of all these being to neutralize the action of the inlet pressure on the valve.

Introducing to the notice of the members a series of pressure-diagrams, the author said: It will be as well, at this point, to note the alterations in the pressures now maintained compared with twenty years ago. Diagram No. 8 is taken from "King's Treatise on Coal Gas" of that time, and was presumably a typical one at the period, as it is evidently well up to date—showing, as it does, water loading. The day pressure was brought down to a figure we should now consider totally inadequate. In none of the diagrams supplied by many kind friends is the day pressure below 11-10ths—the more general being about 15-10ths.

For many years I had been experimenting with a view to making a governor self-loading, and had a certain measure of success; but I was always baulked by the cupping and uncupping of the holders. Many others had been working in the direction of an automatic governor; and Messrs. Cowan introduced their highly ingenious clockwork arrangement. Messrs. Parkinson

also manufactured Price's patent pressure-changer; but neither of these satisfied my requirements. The first-named was costly, and only worked to pre-determined times and pressures, which might or might not be in accord with the consumption requirements—not to mention the fact of its being dependant upon complicated mechanism and clockwork. The need of such an instrument, however, was so felt that these objections did not prevent its being adopted in many of the larger works. Price's changer failed for the same reasons, besides requiring very considerable attention, which has led to its manufacture being discontinued. However, in Messrs. J. & J. Braddock's self-loading governor something was found to meet the case; and in our new governor-house, carried out in consultation with my old guide and friend Mr. Ford, it was adopted.

A paper having so recently been given by Mr. Whatmough, of Heywood, at the Manchester District Institution meeting,* it will be unnecessary to enter into any description of the governor. Ours was at first fitted with parabolic valves, which worked very well with heavy consumptions, but did not reach my expectations with the lighter summer draughts; and I have therefore had parallel valves substituted, which are a decided improvement, as they are arranged to require considerable movement of the bell with slight increase of the demand.

I may just mention that the clearance alone is nearly sufficient to supply our minimum consumption; the valve movement giving $\frac{1}{16}$ inch opening of the leading slot. The amount of opening of the valve is marked for our varying consumptions, from which you will see that an increase of only 4000 cubic feet per hour causes a movement of the bell of from $\frac{5}{8}$ to $\frac{3}{4}$ inch, according to the pressure given by the different holders.

The principle that heavier consumptions require greater pressures is generally accepted; and we endeavour to meet our individual cases by what at best I must term a "rule-of-thumb" method. The increase of pressure is usually from half-an-hour to an hour in advance of the consumption, while the taking off of pressure is very rarely in accord with the fall in consumption. Diagrams Nos. 11 to 19 have been supplied by *confrères* from our own and other Associations.

The proposition I submit is that the pressure diagram should follow the consumption diagram with minimum and maximum pressures, determined with due regard to the satisfactory supply of the district; and where can you find any better indicator of

* See *ante*, p. 229.

this than the movement of the governor-bell itself? In fact, one of my many attempts was for an electric contact from the governor-bell to ring a gong to warn the attendant that the water-loading tap should be opened when the bell began to respond to the increased demand. But if the holder uncupped, the arrangement of the heights of contacts had to be altered. I have indicated the movements of the bell of the governor by attaching a cord to the pen of our pressure-register; the water having been previously emptied, when the float acts as a weight to keep the cord taut. By maintaining a constant inlet pressure to the governor, the movement of the bell indicates changes in rate of consumption.

I was not surprised to find, from the discussion upon Mr. Whatmough's paper, that some engineers who had accepted the principle enunciated (as evidenced by their introducing a self-loading apparatus) had not found it act up to their expectations; and judging from the light of my own experience, I should imagine they had not tried to find out whether their actual consumptions called for the pressures their preconceived notions demanded. For instance, if a governor is set to start loading with any increase of gas consumption from a minimum of 5000 cubic feet per hour, and reach its maximum pressure with a consumption of 20,000 cubic feet per hour, it is impossible for the governor to start to unload until the consumption has again fallen below that figure (20,000 cubic feet per hour), or to return to the original pressure until the consumption has fallen to 5000 cubic feet per hour; and I could not rest satisfied until this point was cleared up.

I can assure you it is a most difficult matter to accurately gauge the consumption by observation of the rise and fall of the holders —even when correcting for temperature—and get your consumption diagram to entirely agree with the indicated bell movement, which must be absolutely accurate. I find that our lightest holder gives the best results at minimum consumptions, as of necessity the travel of the governor-bell is greater than with a heavier holder. Should it be desired to alter the limits within which the governor works, it can be easily done by altering the level of the loading-vessel by means of a screw, and the capacity of the loading-tank on the governor-bell by lifting or lowering the air-vent pipe. Thus a quarterly adjustment can be made to meet the varying requirements of the seasons.

An advantage, calculated to lead to increased consumption, that this method of loading possesses over the ordinary way, is that the first consumers lighting up under the old method, with

the pressure in advance of the requirements, check their taps to prevent flaring lights, and as others light up, and reduce the local pressure, do not re-adjust their taps; whereas the reverse takes place with a self-loading governor. Further, who of us has not met with the consumer who has small pipes or defective fittings, whom we have the utmost difficulty in convincing that such is the case, as he contends, with some show of reason: "I have a good supply early on in the evening, and can get plenty when I am ready for bed; therefore *your* pipes must be in fault."

You will notice the safety bye-pass governor, previously referred to, to prevent the accidental extinguishing of all the lights by neglect or otherwise. The inlet of this governor is connected to the outlet-main from the station meter and its outlet to the collecting main which feeds the main governor; and it is so loaded as to come into action should the pressure in the collecting main fall below the pressure of our lightest holder, which would be the case if the attendant accidentally closed all the valves, or if the stand-wells became blocked by water or naphthalene, when you at once have the make, and also the stock of gas in the holder into which you may be working at the time, available for supplying the town.

I see that a failure of supply was recently reported where some such arrangement was in use; but it appears to me that in only two ways would this be possible—viz., either the valves were stuck on their seats (proving neglect to try the governor daily), or at the time of the accident the make was going into the same holder as was supplying the town, and which was allowed to become grounded.

The cost of this arrangement is so small—there being no necessity for a full-sized governor—that I cannot understand any engineer who has the means and convenience for adopting it undertaking the risk of his district being placed in the dark by not doing so. I am inclined to think I have made a mistake in adopting a double-valved governor for this purpose, as the valves being usually on their seats there is about 40 per cent. more circumference subject to any sticking action than would be the case with a single valve giving the same area. But, at the same time, the governor is exceptionally quick in action; and I have purposely closed all the valves—so bringing it into action—to show you how little the pressure diagram is affected.

This safety governor is also available for governing the town supply in case of any temporary stoppage of the large governor for inspection. In too many cases when governors have been

ordered, no forethought appears to have been given to the position of the floor-line relative to the connections, with the result that the appearance of many governors has been completely spoilt by their being half buried below the floor-line. This might have been avoided by very slight alterations from the makers' standard dimensions.

May I trespass still further on your patience, to touch upon a particular application of a district governor? The district in question is about three-quarters of a mile from the works, and is a long, straggling district, extending over 2 miles, at an average elevation of 200 feet above the works, with a drop at the farthest end of 50 feet. The main is too small to supply the maximum demand; and consequently we get excessive pressure in the day, and a low one at night. The consumption hardly warranted a larger main being laid, provided with a differential governor. However, I was determined to reduce this excessive day pressure, and accordingly fixed a district governor provided with a bye-pass; the latter being opened by the lamplighter on that district when commencing his rounds, and being closed again on his midnight round. This arrangement worked well for a time, until some incandescent burners with bye-pass lights were fixed. These were jerked out a few times; and consequently the practice had to be discontinued. If anyone has a solution of the difficulty, I shall be glad to hear of it.

I have been accustomed to use the pressure-sheets three times, by having different coloured inks, which is not only a small economy, but means fewer papers to be stored up lumbering the office. With pressure-registers to be obtained at such reasonable prices, I cannot understand any works, however small, being without one or more. I am sure they will repay their cost many times over, as by their means the manager can tell at all times if the men are doing their duty—in attending to the regulation of the pressure and to the running of the exhauster.

At the close of the paper,

The PRESIDENT said they had not much time left; but if anyone had anything to say upon the subject of the paper, he would be glad to hear him.

Mr. FORD suggested, as their time was so limited, that they might more satisfactorily discuss the subject after they had studied the paper closely, through the medium of their printed proceedings. It could be taken up at an early stage of their next meeting.

The PRESIDENT said it seemed to him that Mr. Ford suggested the wiser course. They must either have that day a short and unsatisfactory discussion, or they must leave it over to a future meeting, when they would have more time to properly deal with it. It was really a paper which required digestion at leisure; and he was sure that the postponement of the discussion would result in a very much better one taking place. If this was the feeling of the members, he thought they might adjourn the discussion to their next meeting.

This was agreed to.

Mr. D. TERRACE (Middlesbrough) said he quite concurred in what had been done; but he thought it would very greatly add to the interest of the paper if Mr. Millard, between this time and the spring meeting, would look into the matter of the winter consumption, and tell them something about it. What he had given them all referred to summer or autumn consumption; but the winter consumption would be more important.

Mr. MILLARD said he should be very glad to do that if the members who had supported him by giving him the diagrams he had put before them would further assist. He certainly thought it would tend to the improvement of the discussion if between now and the next meeting members would indicate the movement of their governor-bells and the station inlet pressure. This might help to supply them with information upon some things they were not aware of at present.

VOTES OF THANKS.

Mr. M. DUNN (Goole) proposed a vote of thanks to Mr. Millard, whose paper had, he said, undoubtedly been a very fine one; and, as Mr. Ford had wisely suggested, it needed going over very much before discussion was opened upon it, if they were to do justice to it. He believed Mr. Millard was anxious that the paper should be thoroughly discussed.

Mr. TERRACE seconded the proposition; and it was agreed to.

Mr. S. STEWART proposed a vote of thanks to the President for the manner in which he had conducted the business of the meeting; and it was cordially passed.

The members and a number of friends were entertained by the Newcastle and Gateshead Gas Company to dinner in the County Hotel; and this brought the proceedings to a close.

MIDLAND ASSOCIATION.

AUTUMN MEETING, OCT. 26.

This Meeting was held at the Grand Hotel, Birmingham—the PRESIDENT (Mr. J. S. Reeves, of Bilston) in the chair. There was a good attendance of members.

CONFIRMATION OF MINUTES.

The HON. SECRETARY (Mr. C. Meiklejohn, of Rugby) opened the proceedings by reading the minutes of the previous meetings; and they were confirmed.

NEW MEMBER.

There was only one member for election—Mr. William Langford, the Engineer and Manager of the Longton Corporation Gas-Works.

APPOINTMENT OF OFFICERS.

The PRESIDENT said the next business was the election of office-bearers for the ensuing year. As the members were aware, Mr. J. Ferguson Bell, of Stafford, was the Vice-President; and in electing him to this position, they anticipated his elevation to the higher office. He had therefore great pleasure in proposing that Mr. Bell be elected to that position.

Mr. W. BELTON (Shrewsbury) seconded the motion, which was carried by acclamation.

Mr. BELL thanked the members for the honour they had done him by appointing him to the distinguished office of President, and assured them that during the coming year, he would try to discharge the duties to their satisfaction.

The PRESIDENT next submitted the name of Mr. Thomas Glover, of West Bromwich, as Vice-President.

Mr. R. O. PATERSON (Cheltenham) seconded the proposition, which was heartily agreed to.

On the motion of Mr. B. W. SMITH (Smethwick), seconded by Mr. R. KING (L. & N.W.R., Wolverton), Mr. Peter Simpson was re-appointed Treasurer of the Association.

Mr. SIMPSON briefly acknowledged the confidence of the members, and proposed the re-election of Mr. C. Meiklejohn as Hon. Secretary.

Mr. W. NORTH (Stourbridge) seconded the motion, and it was cordially agreed to.

Mr. MEIKLEJOHN having returned thanks,

On the proposition of Mr. C. DAKIN (Cradley Heath), seconded by Mr. GEORGE HELPS (Nuneaton), Mr. Percy F. Winstanley (Wolverhampton) and Mr. Thomas Berridge (Leamington) were elected to the Committee, in the place of the members retiring by rotation; and Mr. R. King was appointed a member, in the place of Mr. W. Belton, who had resigned office.

Mr. P. H. Fletcher (Evesham) and Mr. C. Dakin (Cradley Heath) were elected Auditors.

Mr. G. HELPS then read the following paper, entitled—

NOTES ON THE HEATING OF GAS-RETORTS.

The author wishes it to be understood that his one object in submitting these few remarks is to obtain information. He has often heard it said that, when one knows nothing, the best thing to do is to keep his ears open and his mouth shut. This may suit some people; but surely there is no disgrace in exposing one's ideas, even if they are wrong, to the sharp fire of criticism. The more severely one is handled, the more "impressions" are, as a rule, left; and the author hopes that, after the members have heard these notes, they will open such a fire of knowledge on him that he will be filled with it. He does not worry about the present position, because, as Ruskin says, "Our happiness as thinking beings must depend on our being content to accept only partial knowledge, even in those matters which chiefly concern us;" and in his determination to be happy, he allows this sentiment to cover the multitude of imperfections.

To proceed, the different systems of heating gas-retorts now in operation are probably covered by the following:—

1.—*Ordinary Direct-Fired Setting.*—The fuel being burned to carbonic acid by the admission of air below the fire-bars, with no attempt at regulating the supply of same.

2.—*Generator Settings.*—(A) The fuel burned to carbonic oxide and then converted to carbonic acid by the admission of cold air; both air supplies being capable of regulation. (B) Same as A, but the secondary air heated by conduction from the direct combustion in the setting. (C) Same as B, but the primary air also heated.

3.—*Recuperative Settings.*—(A) The fuel burned as in generator settings, but the secondary air heated by the waste gases. (B) Same as A, but with primary and secondary air heated by waste gases.

Ordinary firing is undoubtedly a thing of the past, and need not be discussed.

Generator settings without the heating of the secondary air can have but very few reasons for existence.

Generator settings, both with the secondary air heated and also with the primary and secondary air heated by direct conduction, deserve more attention than they have received, in the author's opinion, and will be referred to hereafter.

Recuperative settings are in great favour, and hold a position which, in the author's opinion, is untenable. He has to admit, however, that for some time he has been much fascinated by various ideas relating to recuperation; and, among other considerations, the following at one time presented themselves as particularly worthy of note and adoption:—

(A) The increase of the area of the walls dividing the waste gases from the secondary air, so that the waste heat would be utilized to the greatest possible extent.

(B) Reducing the thickness of the walls to a minimum.

(C) The heating up of the primary air to 1500° or 2000°, or to about the same temperature as the secondary, and admitting it above the fire-bars.

Having had in use for some time several settings embodying these notions, the author offers a few remarks thereon.

For increasing the wall area, bricks were specially designed, in section the shape of the letter U or V, having closed ends, so that a portion of each brick projected from its bed, either from the waste gas passage into the primary or secondary air passage, or *vice versâ*; thus presenting a large surface to the waste gases. The thickness of these bricks was about $\frac{7}{8}$ inch. The bed of the brick was about 4 inches wide. Several of these settings have been at work, have given no trouble by short-circuiting, and, in addition, about 10½ cwt. of coke has been sold per ton of coal carbonized (from about two-thirds North Staffordshire and one-third Yorkshire coal). When it is stated, however, that, comparing them with other similar settings, having an ordinary solid 4½-inch wall between the waste gases and secondary air, no increased quantity of coke was obtained for sale from the same class of coal, you may be inclined to smile.

And now as to heating up the primary air. The author se

out with much enthusiasm to heat the primary air to about 1500°, to start with. To do this it was, of course, necessary to admit the primary air above the fire-bars; it would not be much use heating the air and then admitting it under the fire-bars, where there is usually a quantity of dripping water. This was arranged satisfactorily, and the setting designed so that the primary air could be admitted either above the fire-bars, heated to about 1500°, or below, cold. The setting consisted of six retorts, 21 in. by 15 in. by 9 ft. 6 in. long, and worked exceedingly well with 4-hour charges. The average make per mouthpiece was 8000 cubic feet for a period of two months. The coke sold from this bed for the same time averaged 11½ cwt. per ton of coal carbonized. After working two months, it was found that the hot primary air inlets were very badly burned away and clinkered up; so that it was necessary to shut off the hot primary air and admit the air cold. Of course, the air-slides and dampers required re-adjusting; but after this was done, the results obtained, both with respect to fuel and heat, were in every way as good as those obtained with the highly heated primary air. We could detect no difference whatever in the fuel account.

In making a reliable comparison as to the actual fuel used in different generators for retort heating, the following are taken to be some of the essentials:—

(A) The retort-settings should be exactly similar in each case.
(B) The temperature of the gases entering the regenerator should be known, with analysis of same.
(C) The temperature of the gases leaving the regenerator should be known, with analysis of same; or, in the case of generators, the temperature of the gases entering the main flue.
(D) The test for fuel used should be as extended as possible.
(E) The coal used should be from the same pit in each case.
(F) The make per ton should be noted.

The author regrets that, although he had all these things in mind, they were not acted upon; for when the tests were in hand, his connection with the Hinckley Gas-Works ceased. And thus it was that the furnace gases were not tested, nor the temperatures of the gases taken at the inlet and outlet of the regenerators during the different tests, &c. His object, however, in writing these notes is not to go into the question of the value of any particular system of recuperation, or to give any fancy figures, in pounds of coke used per 100 lbs. of coal carbonized, but simply to state the main propositions which he considers

may, by the results of these tests, taken in conjunction with other considerations (the experiences of the members, &c.), possibly be proved. The propositions are—

1.—That there is no real advantage to be gained in fuel consumption by heating the primary air with so-called waste gases.

2.—That there is no real advantage to be gained in fuel consumption by heating the secondary air with so-called waste gases.

3.—That all the advantages claimed for recuperation can be obtained by generator settings.

4.—That the best method of heating gas-retorts, horizontal or inclined, to-day is by having one producer for several beds, as introduced and adopted by Mr. Carpenter, at Vauxhall.

It will undoubtedly be admitted that all the gases entering the recuperator are not necessarily waste. The question then is, What can truly be designated waste gases in this connection? Surely, only such as are found at the entrance of the recuperator in an ordinary recuperative setting, with the producer, the setting, and the recuperator properly proportioned, so that no extra damper is required for the admission of sufficient secondary air into the setting, but just enough to cause the heated gases to travel at a sufficient rate through the setting to carbonize the desired quantity of coal in the retorts, whether for four, five, or six hour charges; the carbonizing heat being maintained at (say) 2000° throughout the setting, including the bottom retorts.

The author is not aware that many engineers take steps to measure the quantity and temperature of the gases at this point under these conditions. The only rule-of-thumb test is to watch the colour of one's main flue, or the last passage of the recuperator, without this being checked, speaking generally, by any test to discover whether too much secondary air is admitted into the setting, or whether cold air is being drawn into the waste-gas flues by faulty brickwork in the front wall or elsewhere. There are some tests made by Dr. Schilling, given in "King's Treatise," Vol. III., which show a considerable utilization of heat units by the recuperator; but if the author follows Dr. Schilling rightly, this utility is based on what he found in the recuperator. The question therefore is, Were the heat units passing into the recuperator more than was necessary to keep his bottom retorts at 2000°?

The following figures, relating to the approximate percentage

of total heat generated required for the heating of the secondary air, are chiefly taken from "King's Treatise," Vol. III.

The heating power of	C	burning to	CO	is	4,453 units per lb.
" "	C	"	CO_2	"	14,544 "
" "	CO	"	CO_2	"	4,325 "
The specific heat of	. . . . .		CO_2	"	0·2169
" "	. . . . .		N	"	0·2440
" "	. . . . .		CO	"	0·2450
" "	. .		furnace gases	"	0·2360

Specific heat of water taken as unity.

It is known that for the conversion of 1 lb. of C to CO 5·8 lbs. of air are necessary, which, combined with the C, form 6·8 lbs. of producer gases, containing 2·33 lbs. of CO, and that the secondary air required to contain sufficient O to combine with this 2·33 lbs. of CO to form CO_2 is 5·8 lbs. also. The temperature of the producer gases generated by the primary combustion is $\frac{4453}{6{\cdot}8 \times {\cdot}245} = 2672°$; and by the admission of the theoretical further quantity of secondary air (cold), the temperature is lowered to $\frac{4453}{12{\cdot}6 \times {\cdot}236} = 1494°$. But by the second combustion we obtain an intensity of $\frac{4325 \times 2{\cdot}33°}{12{\cdot}61 \times {\cdot}236} = 3386°$, and to this we have to add the temperature of the gases before the second combustion is assumed to take place—1494° + 3386° = 4880°. We therefore find that 1 lb. of C burned to CO_2 heats the 12·61 lbs. of furnace gases, which are necessary for its combustion, to 4880°.

A heat unit is the quantity of heat that will raise 1 lb. of pure water 1° Fahr., or the quantity of heat required to raise 4·2 lbs. of air (52½ cubic feet) 1° Fahr. If it is assumed that 12·61 lbs. of furnace gases heated to 4880° are equivalent to the heating of $\frac{12{\cdot}61}{4{\cdot}2}$ lbs. of water = 3·002 lbs. of water heated to 4880°, we obtain 14,737 lbs. of water heated 1°, or a heat value for carbon of 14,777 units per pound, which is not quite correct; but the difference is not material.

In theory, the heat of the gases when converted to CO is 2672°; and therefore we may consider that the secondary air must be heated to this temperature. It is known that 1 lb. of C requires as secondary air 5·8 lbs. of air; and to raise this quantity of air to 2672°, the heat units required would be 3689.

To raise 4·2 lbs. of air		1°	1	unit is necessary.	
" 5·8 "	"	"	$\frac{5{\cdot}8}{4{\cdot}2}$	"	"
" 5·8 "	"	2762°	$\frac{2762 \times 5{\cdot}8}{4{\cdot}2}$	"	"

These are the heat units, then, that are required, in theory, to heat the 5·8 lbs. of air up to 2672°, or to heat the necessary quantity of secondary air for the proper gaseous combustion of 1 lb. of carbon. Now, if it be assumed that the secondary air was heated by waste gases to 2672° before its admission into the setting, we must reckon that the temperature was not reduced by its admission, but remained at 2672°. This will give a temperature of $\frac{4325 \times 2{\cdot}33}{12{\cdot}61 \times {\cdot}236} = 3386 + 2672° = 6058°$ for the secondary combustion, which is equivalent to the heating of $\frac{12{\cdot}61}{4{\cdot}2} = 3{\cdot}002$ lbs. of water raised to 6058°, or a development of $6058 \times 3{\cdot}002 = 18{,}188$ heat units. Now, assuming that 18,188 heat units are generated when the secondary air is heated to 2672°, and that it takes 3689 units of heat to bring the secondary air to this temperature, the theoretical saving in fuel for recuperation should be $\frac{3689}{18{,}188} = 20{\cdot}28$ per cent.

It was this idea of saving another 20 per cent. of fuel which caused the author to consider the advisability of highly heating the primary air. He had heard so much said as to the enormous quantity of waste heat there was at the disposal of the gas engineer in recuperators, and that for the heating of the secondary air it was not nearly all required, &c., that he accepted this doctrine, and argued that, assuming the secondary air to be all heated by waste heat and 20 per cent. of the fuel saved, there would be an equivalent advantage in the heating up of the primary air. The theoretical quantity of air that is needed for the primary combustion being equal to that required for the secondary combustion, it follows that the heating of the primary air to (say) 2000° should have the same effect on the fuel account, &c., as heating the secondary air to 2000°.

In each case, is not the same amount of heat units conveyed into the setting? This is a point on which the author would much like the opinion of the members. The practical way to decide the matter would be to test the temperature of the producer gases when hot primary air is used, and compare it with the temperature when cold primary air is used. The author has tested the fuel consumption of a recuperator with the division-wall $\frac{7}{8}$ inch thick and of large area, against the fuel used in a similar setting, but having the division-wall of small area and $4\frac{1}{2}$ inches thick, and has been unable to discover any advantage in the fuel account—and he was anxious to find it. He has also tested the effect of heating up the primary air by presumably waste heat to about 1500°, and been unable to discover any

advantage in the fuel account. He therefore submits that if a test be made of the actual waste heat from a properly proportioned producer setting and recuperator, both for quantity and temperature, entering the waste-gas flue, so that the heat units could be calculated, and another test made for quantity and temperature of the gases entering the recuperator—the conditions being practically perfect, and no fuel used beyond that required for maintaining the temperature of the bottom retorts at 2000°—it will be found that the quantity of waste heat being utilized in heating the secondary air would not nearly warrant the attention it has received for a number of years; and that, practically, its recovery has no beneficial effect on the fuel consumption as compared with the results to be obtained by heating the secondary air by direct conduction.

Of course, there never has been any question as to the advisability of heating the secondary air. It is clear that in a highly heated state it is in a much better condition for mixing with the producer gases, &c. The only doubtful point has been whether the secondary air is best heated by waste gases or by direct conduction. It appears to the author that opinions adverse to generators are held because, more often than not, generators in which the secondary air is heated to a very nominal temperature are compared with recuperators with the secondary air heated to about 2000°. Another reason for the favour in which recuperators are held is that a recuperator is good looking, and so appeals to young men, particularly when they see a good, bright heat under the bottom retort of a setting, or at the inlet of the recuperator, and compare it with the heat entering the waste-gas flue, without considering any excess of cold air that may be present—in fact, being quite in the dark with regard to the composition of the waste gases. The very fact of naming the gases as they enter the recuperator "waste" has perhaps something to do with it.

Some gas-works having settings of five small retorts on the generator principle, with the secondary air only heated by direct conduction to a few hundred degrees, and using a mixture of North Staffordshire and Yorkshire coal, sell 10 cwt. of coke per ton of coal carbonized! Again, to take the case of a works using a coal giving 13 cwt. of coke, of which 10½ cwt. are sold per ton of coal carbonized in the recuperative setting. Here 2½ cwt. of coke are required for the carbonization of 1 ton of coal; and if the theory is correct, that with a proper recuperative setting there are sufficient waste gases at the inlet of the recuperator to heat the secondary air, we should require

for the distillation of 1 ton of coal in a generator setting $2\frac{1}{2} + (20$ per cent. of $2\frac{1}{2}) = 3$ cwt. of coke, and there would only then be a loss of $\frac{1}{2}$ cwt. of coke for every ton of coal carbonized. How, then, can the claim made by some people, that recuperation saves 1 or 2 cwt. of coke per ton of coal carbonized, be sustained? All these considerations point decidedly to the proving of all the propositions submitted.

The author has permission, by the courtesy of Mr. Carpenter, to refer in these notes to a paper on the subject read by him before the Southern District Association as long ago as 1886, in which he pointed out that, with a recuperator of an excellent design —certainly one which no recuperator with which the author is acquainted at the present day can surpass—there was no advantage in recuperation. Mr. Carpenter, referring to recuperation, said that, "in spite of the most elaborate air-heating, the fuel economy was then only fractionally higher than with the simpler method. To push further the information thus obtained, the regenerator in one setting was bye-passed entirely, when the fuel used was found to be increased by less than 1 lb. per 100 lbs. of coal carbonized." Mr. Carpenter also shows, at this date, that he was able to sell from beds of sixes between $11\frac{1}{4}$ and $11\frac{1}{2}$ cwt. of coke, including breeze, per ton of Newcastle coal carbonized in his generator settings; and the writer has been unable to discover where this has been surpassed in practical working by any so-called recuperator at the present day. From settings of eight, Mr. Carpenter is now selling $10\frac{1}{2}$ cwt. of coke and 1 to $1\frac{1}{2}$ cwt. of breeze.

Some conservative engineers may doubt the exactness of the test made by Mr. Carpenter when he bye-passed his recuperator, and also the other tests referred to. To them the author would respectfully suggest that before spending any further money on regenerators they should construct a setting having the required essentials for the comparison, and make the test themselves.

The author is so much impressed with what he has seen at Vauxhall, by the courtesy of Mr. Carpenter, that he is of the opinion that, even in small works, one producer for a number of beds is the most efficient and economical system for heating retorts. In conclusion, he apologizes for any indiscretions in the wording of these notes. He trusts that, if he is incorrect in any or all of his ideas, members of the Association will take such steps as will thoroughly convince him of his errors.

At the close of the paper,

The PRESIDENT said the paper dealt with a very important

subject, and one in which the members were all interested. It was too much to expect that they could follow Mr. Helps in the figures he had given them at such short notice, and without having the paper before them. But the general subject he was sure would command a good discussion.

Mr. HENRY HACK (Saltley, Birmingham), called upon by the President, said it was not his intention to speak on the subject. Of course, he had had a great deal to do with regenerative furnaces, and furnaces of all kinds; but he would have been very much better prepared to speak on the question if the suggestion which was made some years ago during his term of office, and which he hoped would still receive the attention of the Committee, had been carried out—of having the papers printed some days before the meetings, and distributed among the members, who would then be in a better position to discuss them. Mr. Helps, in the title, described his contribution as "Notes." If these were described as only notes, he did not know what a paper by Mr. Helps would be like. (Laughter.) Touching the proposition which the author had brought before them, he (Mr. Hack) could only generally say what his experience had been. As regarded ordinary firing, Mr. Helps, of course, dismissed that as no longer worthy of attention. He then proceeded to speak of generators. Well, his (Mr. Hack's) experience was that, with single generators heated from a furnace, they did get a considerable reduction in the fuel account, and a better distribution of heat. With regenerator furnaces, with the secondary air heated but not the primary air, they got a considerable advance upon the single generator. His experience was, further, that, by the heating of the primary air, they did obtain still greater advantages, and that the fuel account was less than in any of the other systems. He certainly should, wherever he could, apply the heating of the primary air as well as of the secondary air, and should recommend it to be done, as being the most efficient furnace extant at the present time. He had had no experience whatever as to the outside furnace spoken of by Mr. Helps, and which was in operation in London at the South Metropolitan Gas-Works. His opinion, however, was that they would not get better results from the outside generator than they would do from a well-constructed regenerator where the primary air was heated and the secondary air also. His view was that it was not possible. There must be some loss of heat in its passage from a large outside generator to the various settings. He knew that it had been stated otherwise; but he could not come to any other conclusion. As time

went on, and they gained further experience, his opinion might alter; but at present this was his view on the subject. He congratulated those who were wise enough to introduce regenerator furnaces some time ago, when it was said that it would not be worth while to save a little fuel, or the benefits would not equal the trouble of putting in such costly structures as regenerator furnaces. Those who did so, did the right thing; and with the present high price of coke, they were reaping the fruit of their foresight. Regenerative furnaces were, in his opinion, likely to be continued in most works.

The PRESIDENT remarked that the views which had been advanced by Mr. Helps in his interesting paper ran contrary to common experience, or to the experience which he apprehended a good many of the members had had; and they were at a disadvantage in discussing a paper of so technical a character without having it before them for consideration prior to the meeting. Therefore perhaps the best thing for them to do would be to adjourn the discussion to the next meeting, as it would be a pity for such a paper to be set aside with insufficient discussion. In the meantime, some of them might possibly be able to make experiments on the subject.

Mr. BELL agreed with the views of the President as to postponing the discussion. It was quite impossible to criticize the figures, and adequately discuss the paper, without consideration, as some of the views enunciated in it were not in accordance with the practice of many members present. He did not think anything would be lost by adjourning the discussion.

The HON. SECRETARY pointed out that the advantage of getting papers in print before the meetings had not been lost sight of by the Committee; but the writers of papers could not always get them prepared in time for this to be done. In this case, it could not be done, although it would have been a great advantage, as it was impossible, in talking of specific heats and percentages, to retain the figures in mind, and to keep to the point. He would therefore propose the adjournment of the discussion.

Mr. W. WINSTANLEY (Newcastle-under-Lyme) seconded the proposition, which was agreed to.

Mr. HELPS observed that he had been too busy to complete the paper in time to have it printed before the meeting; and he willingly acceded to the desire of the members to postpone its discussion.

Mr. B. W. SMITH (Smethwick) was then called upon to read his paper.

INCLINED RETORTS.

As it is arranged that a part of this day's programme includes a visit to the Smethwick Gas-Works, particularly to see the inclined installation in operation, I have been requested to give a short paper upon this important subject.

As you are all aware, "inclined retorts" have now passed through the experimental stage; and what has been in a measure an obstacle to many who proposed carbonizing under this system was entirely removed by the expiration of M. Coze's patent in this country on the 20th of June last. The installation which I shall have the pleasure of showing my colleagues this afternoon will, I believe, be found to be, although small, one of the most improved type. It consists of a bench containing four beds of eight Ω retorts in each, 20 feet long by 24 in. by 15 in. at the bottom, tapering to 20 inches by 15 inches at the top; being set at an angle of 32°, and surrounded by a retort-house 57 ft. by 56 ft. by 42 ft. 6 in. high from floor-level to wall plate. As it is not my intention to weary the members—as is too often done—by giving a complete specification of the work, I shall touch but lightly upon figures.

The contractor for the retort-house shell commenced his work on the 16th of May, 1898; and the arches were ready for filling in on Oct. 19, 1898, at which date the contractors for the work, and also the whole of the ironwork, started upon their part. On Jan. 4 last the fires were put under for drying, and kept on till they were increased to obtain the proper temperature, when the retorts were charged on April 26, since which time, I am pleased to say, they have been kept at work incessantly without one single hitch—except on one occasion when the mains were opened to see what deposit, if any, of pitch or thick tar had taken place.

The chief features for the members to see will be the uniform heats, the mode of charging, the even charges, and the easy way of discharging the coke without tickling. The whole of the retorts are heated upon the regenerator principle, very similar to the plan adopted by Mr. Shoubridge at Salford, having specially prepared bricks for the furnace arches and combustion chambers. Perfect control, to ensure uniformity, is gained by sliding bricks which I have had placed over the ports of the secondary air and furnaces gases; so that in adjusting one both are adjusted, and any local heating is at once avoided. The exit gases to the main flue, which runs under the setting, are controlled by two dampers on each side, placed immediately over the last return, and are again controlled by two dampers, one to each portion of the

chimney, a few feet above the floor-level. The fires are charged direct from the centre retorts only, which we find to be about sufficient to maintain the heats; and from working results they require from 11 to 11½ lbs. of coke for every 100 lbs. of coal carbonized—varying according to the quality of coke produced.

The weight of the charges at present averages 6½ cwt. every six hours; but as soon as the coke-conveyor is at work, I have found, from experiments, that I shall be able to have the same weight every five hours. The coal so far is shot down from the carts to the elevator-pit; being fed by men with shovels. The time occupied in filling the storage-hoppers is about 4½ hours. This I hope to have altered next year, so that the coal may be fed direct from the trucks from an overhead railway into a large storage-tank, to automatically feed the elevator. There is provided the usual crusher for breaking the large coal and cannel; and in front of this a shoot with grating is attached, so that when using nuts or fine coal it may bye-pass the crusher. The coal which we have been using has been chiefly screened nuts supplied from Wigan, Derbyshire, and North Stafford, with an occasional quantity of larger coal.

The nuts or crushed coal is carried up by the bucket elevator, and emptied on to a push-plate conveyor, when it falls through openings fitted with slides into storage-hoppers, one over each bed, which will hold, when all are filled, from 50 to 60 tons. It then gravitates to measuring-chambers, to which special arrangement I would draw the members' attention.

There are three measuring-chambers to each bed; but they are not arranged on the "powder" or "shot" pouch system—this principle being essentially faulty from the fact that the doors are so connected together by levers that both top and bottom doors must, for a considerable portion of their travel, be open at the same time, thereby allowing coal to pass from the storage-hopper into the measuring-chamber while the charge is being made. On the contrary, these measuring-chambers are so arranged that the top door must be completely shut before the bottom one can begin to open; and in its turn the bottom door must be completely closed before the top one can be opened. The arrangement by which this is done is very simple; and it has the advantage that the measuring is exact and certain, depending in no sense upon the quickness or slowness of the manipulation of the levers. The chambers are fixed to the bottom of the storage hopper; and each is worked by one lever hanging vertically when both doors are closed. By drawing the lever from its vertical position towards the retort-bench, the top door is

opened; and by moving the lever from the vertical position towards the wall, the bottom door is opened, when the coal drops down into the charging-shoot. There are three of these shoots, running on rails, one for each tier of retorts, with an internal arrangement for checking the speed of the coal, which has been found absolutely necessary to ensure a uniform and proper charge; provision having been made in the measuring-chambers for adjusting the weight of coal from 6½ to 8 cwt. charges.

The charge when burnt off is allowed to fall by removing a stopper, of a pattern which has been found by the writer to be the most suitable for his purpose. After the coke is run out, the man on the charging-stage opens his lid to see if the retort is clear, pushing away any carbon or tarry matter that might remain in the top. This is a most important procedure, as any obstruction in the mouth of the charging-shoot tends to check the speed of the coal, and thereby produces uneven charges; and this, I think, is the cause in many instances of the complaint of charges having been undulating. In every case the man has to try, either before or after the charge is drawn, for any stopped pipes, which I am glad to say have so far given us little, if any, trouble. This may be due to the larger diameter—viz., 7 inches —of the ascension-pipes, and also to the use of a dry main instead of a hydraulic one. I believe that this is the first and only installation of inclined retorts to which the dry-main system has been adapted.

It will be noticed that there are twin mouthpieces to one pipe of the right hand and centre runners. This I designed with a view of having eight retorts in my setting; and I think if I have to construct again I shall endeavour to avoid this, as it is found that there is a little risk and inconvenience by having two retorts to one pipe; and this I believe is the cause of a slight deposit of pitchy tar in the dry main directly below this pipe, due to the larger area necessary in the ascension-pipe and valve —viz., 9 inches diameter—allowing hot gases to pass off towards the close of the charge, and converting the tar into pitch, which we remove occasionally when shutting down on Sundays.

I have found that the yield of tar and ammoniacal liquor is slightly greater than with the horizontals; although to an observer, when the bottom lids are opened, more tar appears. It should be borne in mind, however, that the gas passes away at one end only of the 20-foot retort; and there is probably less tar from this one end than from the two ends of a 20-foot horizontal retort. When I first started, I endeavoured to lessen this tar by

increasing the heat near the mouthpiece, but found the drying up of the tar was followed by a tendency to stopped pipes.

The retorts are easily scurfed, which I have had done once since starting, although but little carbon had formed. Much greater care is required in getting up the heats with inclines than horizontals. The size of coal should be fairly uniform; but I am of opinion that a difference in the angle of repose or speed in charging would be required if very fine coal were employed. I have not, however, so far, experienced any creeping of the charge whatever.

Many gas engineers have been prejudiced against inclines, believing there must be a considerable loss of gas through an accumulation at the top of the slope which cannot be brought down, or else by the gas being decomposed by passing over a greater heated surface, besides a loss in the illuminating power. This, however, has not been my experience with the installation; the yield per ton and the illuminating power having been equal to the results obtained from the horizontals. With the best of the coal we are now using, and about 3 per cent. of cannel, our make is 10,500 cubic feet per ton of 16¼ candles. I have had a pressure-gauge fixed at the top and bottom of one retort, registering the pressure at these points during the six hours the charge is in. By these the members can see that there is no backed-up pressure at the top of the retort; and, on the whole, there is, practically, uniformity at top and bottom. The slight rises denote where other retorts are shut off and put on.

The quality of coke, as will be seen, is much better than with horizontals; and certainly the drawing and charging cannot be beaten by any power machine. I tried the time it would take to draw and charge the whole of the 32 retorts, and found it could be done in 16 minutes. At the present time we draw and charge every hour; and, with the exception of the bottoms, six retorts are dealt with each hour. We employ three men per shift of eight hours to draw and charge, attend to fires, and wheel out the coke, against eight men per shift of eight hours with horizontals for the same number of beds. The attendance on the gas-engine, elevator, and conveyor is performed by an engine-driver, who is only there when the coal is being raised; and four labourers are employed the same hours, shovelling or wheeling the coal to the crusher or feed of elevator.

I will now give the members a few figures I have worked out as to the comparative cost, arrived at from actual results, of the horizontal and inclined retorts, based on a make per ton of 10,500 cubic feet.

Capital Outlay.

	£	s.	d.	
The horizontals, including hand-drawing machinery, cost	715	0	0	per bed
=	89	8	0	per retort
The inclines, without house, and allowing proportion of gas-engine, crusher, and elevator for four beds (being designed for thirteen beds)	1091	10	0	per bed
=	136	8	9	per retort
Retort-house for ditto	334	5	0	per bed
=	41	15	7	per retort

Working Results in Retort-House with Four Beds Only.

5-hour charges horizontals carbonize per week 382 tons, costing 29·06d. a ton
6 „ „ inclines „ „ 291 „ „ 18·10 „
5 „ „ „ „ „ 382 „ „ 13·79 „

This cost includes all charges in retort-house—drawing and charging, coke and coal wheeling, raising coal to storage hoppers, and attendance to fires.

With regard to the cost of gas into the holders, which was asked for by several members prior to preparing this paper, I have gone into this matter most carefully; and, basing the cost of coal, repairs, and residuals upon last year's results, and taking into consideration the capital account of the works only, omitting all district expenditure, and reckoning the interest and sinking fund at the same rate upon the increased cost of inclines over horizontals, I have arrived at the following figures:—

Per 1000 *Cubic Feet of Gas Produced into Holders.*

	Horizontals, at 5-Hour Charges. d.		Inclines, at 6-Hour Charges. d.		Inclines, at 5-Hour Charges. d.
Coal	13·56	..	13·56	..	13·56
Purifying	0·50	..	0·50	..	0·50
Wages	2·91	..	1·86	..	1·64
Salaries	0·18	..	0·18	..	0·18
Repairs	1·34	..	1·34	..	1·34
	18·49	..	17·44	..	17·22
Residuals	7·60	..	7·60	..	7·60
	10·89	..	9·84	..	9·62
Add interest and sinking fund	3·76	..	3·76	..	3·76
Add additional interest and sinking fund	..	..	0·15	..	0·08
	14·65	..	13·75	..	13·46

Showing distinctly that, although the inclines are greater in cost, the net results are in their favour. Of course, I have not taken into consideration any extra cost in the wear, tear, and repairs, which only time and experience will show.

In conclusion, I should like to take this opportunity of saying how pleased I have been with the substantial manner in which the contractors have carried out their work. None of the machinery or building has given me the slightest anxiety; and it only proves the prudence, with inclines as with other work, of not having cheap work or inexperienced men to do it.

The PRESIDENT, at the conclusion of the paper, said there was not much for the members to discuss; and as they were about to inspect the inclined retorts at Smethwick, it would be more in order for them to do so, and then, if Mr. Smith would allow them, bring up the paper for discussion at the next meeting.

Mr. SMITH said he had not written the paper for the purpose of raising a discussion, but more as a guide to the members before going to inspect the plant. He had not worried them with a lot of figures; and what he had stated was what he had found, and what he would advise in the case of anybody starting an installation of inclined retorts.

VOTES OF THANKS.

Mr. BELL said before the members parted they must express their great admiration for the way in which Mr. Reeves had performed the duties pertaining to the office of President during the past year.

On the suggestion of the PRESIDENT, the Hon. Secretary and the Treasurer were included in the vote.

Mr. SMITH seconded the motion, which was heartily passed.

The PRESIDENT said he was much obliged to the members for this expression of their approval of the services he had rendered to the Association.

The HON. SECRETARY also briefly responded for himself and Mr. Simpson.

This concluded the business; and the members immediately afterwards lunched together in the hotel.

THE SMETHWICK INCLINED RETORT INSTALLATION—THE NEW COKE-CONVEYOR.

At 2.30, the members proceeded by rail to the Smethwick Gas-Works, for the purpose of inspecting the new inclined retorts at work and the coke-conveyor in course of erection.* On arriving at the works, the party saw the furnaces fed direct with spent charges from the centre retorts, and witnessed the

* The installation was fully described in the *Journal of Gas Lighting* for May 16, 1899 (p. 1295).

discharging and re-charging of the retorts, all of which operations were carried out smoothly, instantly, and without the slightest fuss. The heats of the retorts and furnaces were examined; and, in fact, the members went all over the installation from the basement to the coal-conveyor in the roof, and left nothing uninspected. Mr. Smith—patient, earnest, and courteous—was inexhaustible in the information he gave to the members in reply to the numerous questions with which he was plied. An interesting impromptu discussion took place between him and Mr. Paterson, as to whether the gas at the upper part of an inclined retort was hotter than that in the lower part; and also as to whether it would not be an advantage to take the gas off from the retorts by means of descension-pipes rather than ascension-pipes.

At the close of the inspection of the inclined retort plant (the installation of which, with the exception of the retort-house and benches erected by Mr. Thomas Vale, was carried out by Messrs. Jenkins and Co.), the visitors proceeded to examine the work in progress for the new coke-conveyor, the contract for which is in the hands of the New Conveyor Company, of Smethwick. Calling his friends together, Mr. Smith addressed them on the subject. He said that, owing to the difficulty the contractors had had in getting material for the work, they had been unable to complete the contract in the stipulated time. This being so, he (Mr. Smith) was only able to show the members the work in progress. The hot-coke conveyor was let into the retort-house floor, being 173 feet long from centre to centre of the driving-wheels, and the width of it at the top was 2 feet and at the bottom 15 inches. The trough was 5½ inches deep, and kept filled with water; and angle-iron scrapers were attached to the underside of the conveyor to take away the dust that might fall from the coke. The chain worked on a wearing surface, consisting of pieces of wood, so that it might run noiselessly; and this could be readily replaced if at any time it became worn out. There were sprinklers placed along the retort-house at different points, to quench the hot coke as it travelled from the retorts. The speed of the conveyor would be about 30 feet per minute; and it was guaranteed to take away 6 tons every half hour, and the coke to be completely quenched. The return chain ran on rollers fixed to a framework in the cellar. The rollers working in brackets were 6 inches in diameter, and placed 3 feet apart. The coke would fall from the hot-coke conveyor into the elevator-pit, and then be raised by an elevator 47 ft. 3 in. in length, set at an angle of 40°, consisting of 18-inch

tray buckets. The overhead conveyor in the yard, upon which the coke was dropped from the elevator, was 192 feet long from centre to centre of the driving-wheels, consisting of a 24-inch table conveyor running on 6-inch rollers 4 feet apart. The whole of the framing and standards was constructed of lattice-work; and on the top of the table were placed V-shaped ploughs, to throw off the coke from both sides at one time at set points of the conveyor. The total height of the overhead conveyor was 25 feet; but the coke would drop from this height on to a sloping surface made by the coke—similar to being tipped from barrows. In this way, they obtained storage room for 2400 tons of coke; and as they had to stack last year practically 2000 tons, they had a fair margin. The coke was screened as it came from the retort-house; and it could be loaded direct into boats and taken away. The motive power was obtained from a horizontal engine, of the Waverley type, and of 20-horse power, driven by steam. It had a 14-inch cylinder and 20-inch stroke. In all probability some of the members would be surprised at the size of the cylinder; but as he could not guarantee more than a maximum of 45 lbs. and a minimum of 35 lbs. of steam, they had to increase the size of the cylinder. The driving was done from a belt to 4-inch shafting placed underground, which was connected to the hot-coke conveyor, and by 3-inch vertical shafting to the head of the elevator, and from there by means of 3-inch shafting placed the whole length of the platform of the overhead conveyor to the driving end of the latter. He could not tell the cost of the coke-conveyor at present; but no doubt the members would like to know what amount it was going to save. So far as he could calculate, it would stack about 2400 tons of coke, and would save in wages from 3d. to 4d. per ton of coal carbonized, and from 6d. to 7d. per ton of coke sold—that was, reckoning upon the amount of coke actually sold last year, and at the present cost of wages. What really induced him to bring the matter before his Committee, and to hasten it forward, was the men complaining as to the laborious work, and the detrimental effect upon their health of having to wheel the hot steaming coke out into the open in the winter; and therefore they insisted upon being paid more money. Something had to be done; and so the scheme which those present had been inspecting had been adopted.

Before leaving the works, the visitors were very hospitably provided with tea and other refreshments by Mr. Smith. The President took the opportunity of proposing a hearty vote of thanks to him for his care and kindness; and this Mr. Paterson

seconded. It must have been a gratification to Mr. Smith to hear from the latter gentleman that he had never seen an inclined retort installation that had given him so much satisfaction as had the one he had viewed that day. Mr. Smith, in responding, bore testimony to the great pains the contractors had taken to carry out his instructions. The visitors also desired Mr. Smith to convey their thanks to his Committee for allowing them to visit the new plant.

The return journey to Birmingham was made just before six o'clock; and there the members separated.

SOUTHERN ASSOCIATION.

AUTUMN MEETING, NOV. 9.

This Meeting was held at the Holborn Restaurant. There was not a large attendance, considering the extent of the membership; but several of the members of the old South-West of England Association were present. Owing to the bereavement recently sustained by the President (Mr. A. E. Broadberry, of Tottenham) in the death of his father, he did not feel equal to the task of attending the meeting and occupying the chair; and, therefore, Mr. ROBERT MORTON, whose interest in the Association has not flagged since his retirement from active participation in gas engineering work, was asked to preside.

DEPARTED FRIENDS—MR. W. H. H. BROADBERRY AND MR. G. E. STEVENSON.

Mr. MORTON, on taking the chair, said he did not think he was the proper person to occupy the position. There must be some Past-Presidents present; and one of them ought to have been invited to conduct the business. However, as the members had desired him to do so, he had much pleasure in yielding to their wish. But it was a sad pleasure, if such a combination of words could be used. He was very sorry for the reason of his presence in the chair—that Mr. Broadberry did not feel equal to the duties on account of his father's death. He (the Chairman) thought the first thing they ought to do was to refer to that sad event. The late Mr. W. H. H. Broadberry was a very old member—one of the original members of the Association. He had known him for a good many years; and he was certain that they all held him in very great respect. Mr. Broadberry was a plain man, but a very practical one. He was ever ready to give all the assistance he could to anyone in the profession, as well as to the Association when President of it, and since then. He would propose that the members assembled pass a vote of condolence and sympathy with the widow and family of their late respected friend, and that the Hon. Secretary communicate the vote to them.

Mr. J. T. JOLLIFFE (Ipswich) seconded the motion, which was passed by the members silently rising.

The HON. SECRETARY (Mr. J. W. Helps, of Croydon) said he had also a sad duty to perform, and that was to propose a similar vote of sympathy and condolence with the family of the late Mr. G. E. Stevenson, of Manchester, who, as the members knew, had been called away during the past week or so.* He believed most of those present personally knew Mr. Stevenson, and those who had not that pleasure must have known him very well through the work he had done in connection with the gas industry. His death, as they were aware, was a very sudden one; but the feeling was prevalent among them that he died the death which possibly many might wish—to die at their posts when carrying out their duty to the best of their ability. He had, to use the expression of the Chairman, a sad pleasure in proposing that a vote of sympathy and condolence be passed, and that a copy of the resolution be sent to the widow and family of the late Mr. Stevenson.

Mr. C. E. BOTLEY (Hastings) said that he had the melancholy privilege of being allowed to second the motion proposed by Mr. Helps. He was sure they must have all been horrified to read in the papers the account of Mr. Stevenson's death. The suddenness was appalling; and the circumstances were deplorable. He had the privilege and pleasure of knowing Mr. Stevenson during his professional career. Only recently he had had negotiations with him, and had seen him and his Chairman at Hastings. Many were the enjoyable meetings and chats over professional matters that he had had with their late friend; and it came upon him with an awful shock when he heard that the man he had so lately seen was no more.

The CHAIRMAN said this was a very sad duty they had now to perform; and it was, in its circumstances, different from the other. The suddenness and awfulness of Mr. Stevenson's death came upon them all, he was sure, with very great regret.

This vote was also passed by the members silently rising.

CONFIRMATION OF MINUTES.

The HON. SECRETARY then submitted the minutes of the last meeting; and they were confirmed.

OFFICIAL ELECTIONS.

Mr. BOTLEY had much pleasure in next proposing that the Vice-President (Mr. D. Irving, of Bristol) be elected to fill the

* The painful circumstances attending Mr. Stevenson's death, as well as an account of his life-work, will be found in the *Journal of Gas Lighting*, Vol. LXXIV., pp. 1079, 1117, 1127, 1193.

presidential chair during next year. He was sure that the Committee, in making the choice they had, had exercised a wise discretion. The members had known Mr. Irving for a good many years; and he had charge of very important works. He (Mr. Botley) was satisfied they would have in him an extremely good President during the ensuing year.

Mr. F. W. CROSS (Lea Bridge) seconded the proposal. The Committee, he said, were unanimous in selecting Mr. Irving; and he was sure the affairs of the Association would be in very safe hands during his tenure of the office.

The motion was unanimously agreed to.

Mr. IRVING heartily thanked the members for the honour they had done him in selecting him to be President of the Association during the forthcoming year; and he could only say that, with the kind co-operation of the Committee, and the assistance of the members, he should do all in his power to maintain the usefulness of the Association.

Mr. W. E. PRICE (Hampton Wick) said he had a very pleasant duty to perform, and that was to propose the Vice-President for the ensuing year, who, in the usual course of things, would be President during the following year. When he mentioned the name, he was assured one and all would agree that no other gentleman could have been selected to fill the position so ably. It was very necessary in an Association of this description, in electing a Vice-President, to choose one who they were convinced would be a benefit to the Association both as Vice-President and President. Without going far into the matter at the present time, he should like to say that they should all put their "shoulders to the wheel" to support their Presidents, Vice-Presidents, and Committee. It was, he thought, pretty obvious that some of them were not doing all they could in this respect; otherwise the meeting that day would be equal to the meetings they had had in the past. He thought the gentleman whose name he was about to mention would—in fact, he was certain he would—have the effect of drawing the members together, and making the Association as flourishing as it had been in the past. Therefore he had the greatest gratification in announcing that Mr. Corbet Woodall had consented to be nominated for the office of Vice-President; and, of course, in all probability, he would be President the succeeding year. He hoped the members would reward Mr. Woodall for his kindness in taking the position by gathering round him in far larger numbers than they had assembled in of late. It rested with each member to do what he could to continue the Association, and to show

that they were still alive and not in a moribund condition. He had therefore much pleasure in proposing that Mr. Woodall be elected Vice-President for the coming year.

Mr. W. B. RANDALL (Waltham Cross) seconded the resolution, expressing his firm conviction that the work accomplished during the presidency of Mr. Irving, and afterwards of Mr. Corbet Woodall, would redound to the credit of the Association.

The CHAIRMAN, in supporting the motion, mentioned that he had had a lifelong acquaintance with Mr. Woodall, and was, he believed, the first to introduce him to the gas world.

The motion was carried with applause.

Mr. NORTON H. HUMPHRYS (Salisbury) proposed the election of Mr. D. H. Helps (Redhill) and Mr. T. W. R. White (Sherborne) as members of the Committee.

Mr. W. B. MIMMACK (St. Mary Cray) seconded the motion, which was passed.

Mr. J. LOWE (Weymouth) proposed that the Hon. Secretary and Treasurer (Mr. J. W. Helps) be again elected to this responsible office, which he had filled so many years. To the admirable manner in which he had served the Association, and the energy he had thrown into its work, they were indebted for its present prosperous condition.

Mr. F. C. TAYLOR (Shanklin) seconded the motion.

The CHAIRMAN remarked that the proposition needed no recommendation from him; Mr. Helps having been such an active and successful Secretary. He (the Chairman) agreed with Mr. Price's statement as to the lack of help that their Secretary had received from the rank and file of the Association.

The motion was cordially carried.

The HON. SECRETARY, having thanked the members for this renewed expression of confidence, said he should like to take the opportunity of backing up what Mr. Price had said, in hoping that the Presidents in the future would receive greater support than they had done during the past few years. Through no fault of the Presidents—and, he could assure them, and hoped they would believe, through no fault of the Secretary—but for some unknown reason, their meetings had of late lacked that vivacity and that large attendance which had characterized them in years past. As he had said before, it was not much good talking to those who were present; it was those who were absent that he wanted to talk to. He hoped, as Mr. Price had said, that all the members would put their "shoulders to the wheel," and ensure that in the immediate future the Association should show much greater strength and vivacity than it had

during the last year or two. He was sorry to say this; but it was a fact that had been known.

Mr. T. H. NIXON (South Metropolitan Gas Company) moved the re-election of Mr James L. Chapman as Auditor, and the appointment of Mr. A. Dougall as his colleague, in place of the late Mr. W. H. H. Broadberry.

Mr. R. WATSON (Hertford) seconded the motion, which was passed.

NEW MEMBER.

On the motion of Mr. S. W. DURKIN (Southampton) seconded by Mr. W. D. CHILD (Romford), Mr. E. P. Reilly, of Guildford, was admitted to membership.

Mr. N. H. HUMPHRYS (Salisbury) read the following paper :—

THE MANAGER'S TOWN OFFICE.

The attitude of a gas company as regards the consumers of gas, as a general rule, has passed through three stages. First, there was the indifferent attitude. The price of gas was kept at a good substantial figure, sufficient to ensure full dividends without much trouble or risk; no special notice was taken of complaints; the quality of the article supplied was not always above reproach; new consumers had to wait the convenience or the pleasure of the service-layers before the supply was laid on or the meter was fixed, and also to pay a deposit or give a guarantee, or put up with other vexatious restrictions, besides bearing nearly the whole cost of the service; and no interest whatever was taken in the state of affairs on the other side of the meter. Indifference on the one side led to distrust and dislike on the other; and these sentiments occasionally crop up years after the causes have been removed—many undertakings now suffering in this respect for the sins of their fathers.

The second stage was the conciliatory attitude. Keen, business-like, fair-minded directors and managers saw that the above condition of affairs was not desirable or advantageous; and they recognized that the interests of the consumer should be considered to the extent of supplying him with a good article at the lowest possible price. The Special Act of Parliament was put away on a top shelf, instead of being on hand ready to flourish in the face of any and every malcontent who ventured to hint that the gas might be better in quality or lower in price. Some authorities stop here—claiming that the duty of the company towards the consumer goes no farther; and justify such a course by saying that expenses should be reduced as much as possible,

so that gas may be sold at a low price. Cheap gas, they say in effect, will advertise itself.

The third stage I will call the enterprising attitude. It takes in both the encouragement of the use of gas and the education of the consumer. It recognizes the fact that a low-priced article is not necessarily cheap, and that there is no such thing as automatic advertising in these days. Two-shilling gas consumed through a dirty iron tip gives less satisfaction, and costs more, than three-shilling gas passing through a Sugg table-top burner. So it takes in not only the supply of apparatus on hire or hire-purchase terms, but the fixing, instructing in use, maintenance, and keeping in order, of the same. It brings in an entirely new department, which may be called the selling department. I agree that this addition should not be a charge on the general expenses, and that it should not be worked at a loss. The expenditure side of the revenue account should carry no costs beyond the ordinary manufacturing, distributing, and establishment charges. But I contend that the enterprising attitude need not be ignored on this excuse, as, if properly worked, the selling department will pay its own footing, and, indeed, yield a small profit. Then it has been urged that gas companies should not increase their risks. I never could see why a gas company should avoid risks that are no detriment to ordinary traders; but as this objection is now somewhat out of date, no more need be said about it.

The town office is an almost indispensable adjunct to the enterprising attitude. The gas-works are usually situated on the outskirts of the town, in a locality where land is cheap—which means the poorest and most insignificant suburb. They are a mile or more from the centre, and probably double this distance from the best residential parts. The approach and surroundings partake more of the nature of an East-end slum than of a Parisian boulevard; and there is a general objection to calling at the gas-works. The better class of consumers, in particular, reckon the gas-works on a par with the town rubbish-yard and the sewage outfall; and they would as soon visit one as the other. Apart from any sentimental prejudice, the distance is a disadvantage; and this applies in a greater degree to the company than to the consumer. More meters, stoves, and fittings will be required at the best end of the town than at the other; and there will be more complaints to attend to. If a meter or stove has to be fixed, a fitter and his mate must go from the works to the premises, carrying the meter with them, together with tools and other things required, and these must be duly returned to the works

after the job is finished. If a complaint reaches the office as to a defective meter, service, or lamp, the fitter and his mate must again go from the workshop to the site of the complaint, and possibly do not or cannot take all that they want on the first visit. The advantage of transferring the outdoor business to a central site is a large reduction—more than one-half—in the time lost by journeys between the shops and the consumer's premises, and also in the carriage of materials and tools. More than this, promptitude is a great consideration in the case of accidents or large escapes of gas. A fitter coming from the central office may reach the site and prevent all risk or danger before a man starting from the works would be half way there. Substantial penalties are sometimes insisted on in the case of defective public lights. The lighters can report themselves at the town office at the close of their rounds, and at the same time give in a list of defects, thus facilitating prompt attention.

The town office should be something more than a gas-fitter's shop. The business of a gas company is to sell gas and residual products; and the town office should not be devoted to one department only, but be a fair representation of the whole. While the company do not disdain the proverbial honest penny in the shape of trading profit, the main object is to encourage consumption of gas and residuals—to strengthen the old lines of business, as well as to develop new ones. So the sale of a 5s. article that will be in operation and consuming gas for some hours each day may be more advantageous to the interests of the company than the disposal of a £5 appliance that will only be employed occasionally. As regards the supply of apparatus on hire or hire-purchase terms, the direct profit on the transaction is scarcely worth consideration. Apart from the consumption of gas, it would not be a profitable business; but when it is the means of securing a steady consumption—an end that is worth some trouble, and even expense, to secure—the hiring department becomes a source of indirect profit. All the general outdoor business of the company should be attended to at the town office. Customers should not only be able to inspect stoves, burners, and fittings, but to pay accounts, and give all classes of orders, not only relating to gas, but to the various residuals manufactured by the company. Attractively arranged samples should be shown, together with a boldly-designed price board, which also bears the announcement that all goods ordered will be delivered at the customer's residence. Samples of sulphate of ammonia in 2-lb. jars of clear glass, which will contain about 1½ lbs. of the salt, will find a steady sale.

In my own office there are samples of ordinary coke, household coke, small coke No. 1 and No. 2, and coke breeze, exhibited in wooden boxes, shaped like the old-fashioned coal-scuttle, and painted black. What I call household coke, small coke No. 1, and small coke No. 2, is broken coke about 2½ inches cube, broken coke that passes the screen on the breaker, but will not pass a ½-inch screen, and ash-pan breeze that will not pass the same size. Breeze is the small material that passes the ½-inch screen. The assistance afforded to our residual trade is sufficient to pay the rent of the office and the salary of a clerk. We continually find residents of long standing coming in and ordering various residuals, and remarking that they would have been glad to have had some before, but did not know we sold them. Before the town office was opened, there were hundreds of people who scarcely knew that we sold coke or that the trade in residuals was a steady-going affair of respectable dimensions.

A prominent feature should be made of the lines of apparatus offered for hire. They should be shown in operation, and carry labels clearly setting forth the terms on which they are supplied. The stove should not be allowed to overshadow the lighting burner. The tendency of late years has been to leave the primary object of the gas industry to take care of itself. Demonstrations and exhibitions are held, at which the advantages of gas-stoves are set forth; but the gas-burner is frequently left out in the cold. One of the principal objects of the town office should be to set forth the advantages of gas as an illuminating agent, and that not for the poor only, but also for the rich. Gas has paramount advantages for the cottage; but, as regards the castle, it is capable of affording service that cannot be obtained from any other agent. Gas companies, in my opinion, are not only too ready to take a back-seat in the matter of illumination, but also to leave the principal thoroughfares and go into the slums. A good show of incandescent burners should be made, and the company should be prepared, not only to fix, but also to adequately maintain the same at a moderate charge, including the necessary renewal of the mantles. One thing that has helped the cooking-stove is the fact that the company maintain it in repair; and if it is worth while to keep the cooker in efficient order, it is worth while to do as much for the burner. The maintenance of incandescent lights is by no means so troublesome or costly as some appear to suppose. In many instances—such as for places of worship, reading-rooms, museums, &c.—it is a mere trifle. At Salisbury, we have had 500 street-lamps and as many private gas-burners, some inside and some

outside, on our hands for a year; and the maintenance business is developing steadily.

The town office should include a clerks' or rental department, where all books relating to the accounts of the customers should be kept; a show-room for stoves and fittings; stores for meters, service-pipes, &c.; and workshops for the repair of stoves and fittings. It will be a convenience if room can be found for lamp stores, painting and repairing shops, &c., so that the street-lamp department can be worked from the town office. The board-room and secretary's office may also be on the same premises. This really means that the necessary block of buildings should be erected by the company, as it is very unlikely that premises can be found which admit of all these arrangements. It is not every company that is in a position to launch out so extensively. It may be a case of dispensing to a greater or less extent with some of these departments. If such is unavoidable, half a loaf is better than no bread; and even an ordinary shop, provided the situation is good, can be turned to useful account.

All who are desirous to move from the conciliatory to the enterprising attitude will do well to remember that enterprise spells capital, and that dividends are made in the retort-house. As regards the first point, it may be possible to squeeze the cost of a few dozen services and meters per annum out of the revenue account without feeling the pinch; but modern requirements in a district that has not previously been exploited cannot be met without more considerable outlay. This fact should be clearly brought before the directorate, and discussed by them in the first place; for it is a mistake to incur responsibilities for outlay, trusting to Providence for a way of meeting them. Nor can the acquirements be accurately forecast, as they will depend upon the response received to the offers made. If a company decide to take up the slot-meter business, there may be 500, 1000, or 2000 applications, according to how the thing takes. If the directors determine to limit the outlay to a fixed sum per annum, or to impose other restrictions, the manager will then know what to do. As regards the second point, the time-honoured axiom of Mr. Newbigging, which is more extensively quoted perhaps than any other, was never of more importance than at present, when the manager is expected to do everything that everybody else is doing, and a little more. While he can keep a general supervision over the town office, and deal personally with specially important cases, he cannot be at the beck and call of every Tom, Dick, or Harry who wants to buy a Welsbach burner or a 1s. 6d. boiling-ring. He must rely for the

carrying out of details upon a competent staff of assistants. His place is at the works, as the retort-house and purifier-house require as much attention now as ever they did. The manager's private office should be at the gas-works; and with the aid of a telephone connection, he can keep very well in touch with the town office.

I remember hearing an old gentleman, who had retired from business after half-a-century's experience as a carpenter and builder, remark that he had never solicited an order in his life; but business cannot be kept together on these lines at the present time. Touting of all kinds, direct and indirect, is carried on with feverish eagerness; and the man who knows how to sell ordinary articles is quite as successful as the man who can invent and manufacture great improvements. It is not enough to make a good article and trust that it will advertise itself; and the men or the companies who consider that they can afford to dispense with the selling department, must be prepared to take back seats, and to see their own commodity displaced by goods admittedly inferior in quality, but more energetically or attractively set before the buyers. When we see what can be done by a keen study of the art of selling, we cannot but wonder what the sales of gas would be if it was exploited with the energy bestowed on other less-deserving articles, if it was advertised regularly, by newspaper, handbill, pamphlet, and poster, and if there was a house-to-house canvass, as has been done in some towns in America, with special attention to the reasons why gas was not used, and to remedying or removing the same. Many gas companies can claim to share with my old friend the honour of never having solicited an order; and if a good business grows up under such unfavourable conditions, it is not too much to claim that it could be doubled or trebled by careful attention in the selling department. There are only a few odd corners now in the world for the people who do not solicit orders; and soon there will be no room for them at all.

For the sake of convenience, I have spoken only of the manager of the company; but I do not lose sight of the fact that the business is carried on by the secretary as well as the manager, and that very wide variations obtain as to the duties and the responsibilities of these officials respectively. The secretary may be little more than a legal adviser and clerk to the directors, or he may keep the books and control the whole of the business operations; and the position of the manager may consequently vary inversely. He may simply act as technical adviser or

superintendent, having nothing to do with the books or accounts, or he may also be responsible to the directors for the whole of the commercial operations. In works of any magnitude—say, over 200 million cubic feet per year—there is plenty of room for a competent engineer to make and distribute the gas and act as general technical superintendent, and also for a commercial manager who should superintend the finances and the business dealings; and in large companies, the entire outdoor department may with advantage be handed over to the supervision of a skilled technician.

These are views on the subject of the manager's town office that are based on my own experiences. Some of you may not agree with them; and others, finding themselves in widely different surroundings, may have adopted different methods. The question is one that deserves careful consideration from all points of view; and having freely and unreservedly stated my own opinions, I hope other members of the Association will follow suit, and that we may have a useful and profitable discussion.

Discussion.

The CHAIRMAN, in inviting discussion, said the paper gave the writer's own experience on the matters dealt with. It did not require any technical knowledge to discuss it; but it was not the less valuable on that account.

Mr. S. W. DURKIN (Southampton) was sure the members were obliged to Mr. Humphrys for his very practical paper. He did not suppose it would be possible, as the author had intimated in his paper, for all of them to carry out his recommendations in detail. As far, however, as Southampton was concerned, they were acting somewhat on the lines laid down. They had a town office and an office at the works. The town office was under the control of the Company's worthy Secretary and his staff; and he (Mr. Durkin) had personally nothing to do with it. But some years ago they had a vacant room there which was fitted up as a show-room for the various gas-ranges that the Company let out on hire, as well as gas-fires, and a series of up-to-date burners. Although he was not personally in charge of this room, he might say that it was a great advantage to the Company. The stupidity of the public was something amazing. They wanted this stove or that stove; but they could not tell exactly what they did want. He had directed people to go to the show-room, and see what there was there; but even then they could not always find what they wanted, and had again tried to describe to the attendant what it was they actually did require. Some others really did not know

where the town office was, and when informed that they would perhaps see there what they needed, would say: "I will think about it," or "I will call in when passing that way." He presumed that a person of this description was not very sincere in his requirements, and possibly never turned up at all at the town office. But, on the whole, the show-room had been a very great success, and had no doubt brought in a good deal of custom to the Company. So far as the outdoor department was concerned, he had that under his own control; and from his office at the works, the whole district was commanded. The town office took orders for service-pipes and anything else the Company dealt in; and then all these matters were transferred to him for his staff to carry out in detail. Mr. Humphrys made some allowance for their surroundings; and he (Mr. Durkin) had to accept the position as it was. They did their best, and gave every facility to the consumers, in regard to the supplying of their wants, and attending to their various complaints, whether they were good, bad, or indifferent. The consumers got fairly good, if not very good, attention to their requirements. He quite agreed with the general principles laid down in the paper; but there was one point they should remember in connection with the letting out on hire of gas cooking-ranges. He thought, where a district was a large and growing one, it would answer a gas company's purpose to appoint a lady superintendent to go round and instruct the ladies in the proper use of the gas-stoves. As he had observed before, and others had remarked the same thing, servants were the greatest enemies to the extension of gas for cooking purposes; and he thought, if a competent person were appointed to go round and initiate mistresses and servants in the proper use of these things, much good would result. Directors did not always see eye to eye with their officials; but the day would come perhaps when they would become more enlightened. He had a very good man who had full charge of the fixing up of the stoves. He gave all the instruction he possibly could to the consumers, and, if a second visit was necessary, he attended to it. So far as he (Mr. Durkin) could gather in coming in contact with people, they spoke very well as to this man's ability in assisting them to employ the gas to the best possible advantage.

Mr. F. G. Cockey (Newport, I. of W.) considered it was an excellent thing for a company to have an office in the centre of the town. Of course, the circumstances of different companies varied so very materially that it was an impossibility for all companies to have a town office. For instance, the relative

sphere of control of the secretary and manager in various places was so very different. In one case, the secretary would be merely the clerk and perhaps legal adviser to the directors; and in another case he would be practically the commercial manager of the undertaking. Then, again, if there was a town office, it was almost necessary, in order for it to be a success, that there should be a technical man in charge of the show-room—a man with sufficient technical knowledge to explain everything appertaining to the consumers' requirements. But the resources of small companies would not always permit of the employment of a man of this character. The manager's place was at the works—in the retort-house and the purifying-house—watching the details of manufacture; and he required a fully competent man to take charge of the selling department —a commercial man, sufficiently technical to explain everything to the customers. He thought the tendency now was, if they did their best, to go beyond the second stage Mr. Humphrys had mentioned, and take the consumers in hand and try to educate them. In his case, they sent a man round to show them how to properly use their cookers and gas-burners, and to do any small repairs; but they did not ask the consumers to call them in and abuse them for defective lights and apparatus which had been put in, in a more or less unworkmanlike way, by retail tradesmen. He thought all the members appreciated the principles that Mr. Humphrys had laid down in his paper; but it was simply their individual circumstances that might prevent them adopting them all.

Mr. DURKIN added to his previous remarks that in his case they had telephonic communication between the town office and the works; and this he found an advantage, though the tinkling of the bell all day long was a sore point with him. (Laughter.)

Mr. C. E. BOTLEY (Hastings) said, as already pointed out, the general principles mentioned in the paper were entirely those which, in well-directed concerns, were practised in these days. He did not think there was any question about the desirability of carrying out all the means that Mr. Humphrys suggested for developing consumption and giving the consumers information. There were three attitudes mentioned by Mr. Humphrys in his paper—the indifferent, the conciliatory, and the enterprising. Now, he (Mr. Botley) hoped there was no one present—he did not think there was anyone—who had ever been in the attitude of indifference. He could not himself see that the desire for improving consumption in every possible way was not as keen in the past as it was at the present time. The means, it was true,

were not so great then; but still there was a good deal to be done in those days. He could not imagine a state of things where the indifferent attitude was struck. If people had not the means of largely developing consumption, how could they be expected to do it? Then he could not imagine an engineer not practising the conciliatory attitude. He had so many cases of complaint to meet—imaginary or real—that if he was not conciliatory he would soon find himself in a bad way. The enterprising attitude, too, was one which was very much pushed in these days. For some years past, they had at Hastings developed the enterprising attitude. They had given every facility for people to get the best light possible, and they also rendered a great deal of gratuitous assistance in various ways. With regard to the question of cooking-stoves, he might mention an example of what had recently been done at Hastings. One or two complaints came in from users of cooking-stoves. They got on fairly well with them, but said they would like to see how a cooking-stove was managed. The Company thereupon engaged a lady to come down to Hastings, and invitations were sent out to the consumers to attend the Company's offices, where the lady referred to showed them how to use the cooking-stoves to the best advantage. This, he need hardly say, was highly appreciated, and resulted in a great increase of business—due simply to the enterprising way the matter was taken up.

Mr. J. T. JOLLIFFE (Ipswich) said he was quite at one with Mr. Humphrys in the principles set forth in his paper. They had for many years at Ipswich had offices in the centre of the town; and they had been of untold advantage to them. He would go further, perhaps, than Mr. Humphrys. He would not only do everything that Mr. Humphrys did, but he would also employ a skilled official who could go round and explain everything that could be explained, and could advise in every direction. Not only that, but he would also (as they did, as a matter of fact) employ a woman—not perhaps a lady, as Mr. Botley said—who thoroughly understood the use of the gas-oven, and was able to explain to anyone who wanted such information the use of it. They had also found an advantage in having lecturers who were able to give demonstrations in the town offices to the consumers. These lectures were carried on for a long period; and invitations were sent out in every direction. The result of this was a considerable amount of good. In addition to this, he thought it was highly desirable that gas companies should try, as far as possible, to get the whole of the gas-fitting business

into their own hands. If there was a house to be fitted up, the ordinary gas-fitter seemed to go about it with an utter disregard of what was really needed; and it was only after the poor consumer got into the house that he found out how the work had been executed. Only two or three months since, an example of this came under his notice. There were some new houses, letting at £60 a year, which were fitted up by gas-fitters employed by the builders; and, as soon as tenants got into the houses, they had to apply to the Gas Company for assistance. The houses were so scandalously fitted up that there were leaks in all directions, and the pipes were far too small. If gas companies would work with the idea of getting as much of the gas-fitting into their own hands as they could—not so much for the profit as to have the work done in a satisfactory way for the consumer—they would be doing both the consumer and themselves a great deal of good.

Mr. W. E. PRICE (Hampton Wick) entered a protest against the first paragraph of the paper. He did not think that, taking the gas industry as a whole, it was right to say they had treated the consumers in the way there described, nor did he think it wise it should go forth that a gas manager in a meeting of this sort had said that consumers had been treated in that way. They did not know where the paper might get to; and it might be brought up against them by a consumer, who would say: "I told you so—you used to be indifferent, and now one of your own men says so himself." He did not think, in the discussion, it had been agreed that this was the case.

Mr. R. WATSON (Hertford), referring to the cost of the maintenance of incandescent burners, said it seemed to him the comparison between incandescent burners and stoves was scarcely a fair one. Stoves could not be broken in the same way as mantles; and to take over the maintenance of incandescent mantles appeared somewhat risky. It would be of service to the members, in introducing this business, if they had a few figures on the point, which would add to the value of the paper. At Hertford, which was a comparatively small town, they had a town office, and in conjunction with it they dealt with the rental work. They also had a fitting-shop and fitting business and show-room. The fitting business answered not so much as a business, but they got the whole of the fitting in the town in their own hands, with the result that they were able to see that the correct sized pipes were satisfactorily placed in the houses. So much were the Gas Company trusted in this respect, that they not only obtained the custom of the private consumers, but

they also did the bulk of the work for the builders in the town—of course, at a reduction for them.

Mr. HUMPHRYS said he did not think that much had occurred in the remarks made upon the paper which called for a reply. Of course, as he had already observed, the experience of others might be different from his own; but what he had said in the paper was based on his own experience during something like thirty years. As to the maintenance of incandescent burners, he considered it a great mistake to say they would maintain burners at 6d., 9d., or 1s., as the case might be, because so much depended on the position of the burners. In a place of worship, a museum, or a reading-room, where there were no labouring or mechanical operations going on, the maintenance was a mere nothing; but, on the other hand, in a factory or a public-house or a club-room, the maintenance might come to a considerable sum. In his own case, he undertook maintenance at varying prices. In some instances, they had put in the fittings, and the maintenance was included in the cost of the fittings under a seven years' contract; and in other cases, they had undertaken the maintenance at 6d. per burner per quarter. In one case he undertook it at 10d. per burner per quarter. They had a staff of three or four men told off to get their hands in; and they became very expert at dealing with the burners. He found that 6d. per burner per quarter was a very good estimate for the maintenance of the burners.

Mr. WATSON: In private houses?

Mr. HUMPHRYS: Yes. Continuing, he said he did not undertake less than a dozen burners on these terms. The men cleaned the chimneys; and the charge included renewal of mantles.

Mr. WATSON: Is labour included in the price named?

Mr. HUMPHRYS answered that, where there were a few hundred mantles to deal with, the labour did not amount to much per burner. The men could see to a good many burners in the course of a day.

Mr. H. O. ELDRIDGE (Tottenham) read a paper entitled—

GAS SUPPLY BY AUTOMATIC METER.

At the request of your President, I shall endeavour in this paper to lay before the Association some information, and to relate some of the difficulties, troubles, and successes we have experienced in the commencement and continuation of gas supply by automatic meter. I do not suppose much of the information will be new, or of a nature greatly different from that encountered

by members of the Association in the promotion of work of this description.

The opening attempt by my Company was made in 1893, at the end of which year we had about 70 meters in use. At the close of the present year (1899), the number will exceed 8000; ours being, I believe, the first case in which the number of slot meters has exceeded the total of ordinary consumers. Our district is well situated for automatic gas supply; being only a few miles north of London, and well furnished with a service of cheap workmen's trains. The builders find that, no matter how fast houses are erected, would-be tenants apply, as occupiers, before the first brick is laid. They do not build here in terraces or streets, but lay out enormous estates at once, and soon convert what were smiling green fields to row upon row of bricks and mortar, all consisting of cottage property or small shops, for which the slot meters are suitable, and are eagerly applied for. By a little judicious canvassing, fully 75 per cent. of these occupiers can be induced to burn gas. In most cases, the house is inhabited by only one family; and there is not the trouble and continual expense to the Company that is entailed where lodgers are supplied. Though extending so fast, we have in this district still vast tracts of market fields and agricultural lands that leave ample scope for time to come.

The 1898 Collection.

It may be of interest to state first the particulars of our last year's collection (1898). But I will mention, in parentheses, that we are charging for ordinary supply 3s. per 1000 cubic feet; and by slot meter we furnish 22 cubic feet per penny. Many of our first meters were set at 3s. 8d. per 1000 cubic feet, or 22½ feet per penny; and a large proportion of these are still in use. The gas consumption for the year was 85,800,000 cubic feet; the number of meters was 6860; and the money collected and paid to the bank, £16,130. This gives averages as follows:—

Gas per meter	12,500 cubic feet.
Money per meter	£2 6s. 10d.
Price per 1000 cubic feet	3s. 9d.

Taking the total collection—£16,130—as a basis of calculation, £12,870 is taken for cost of gas at 3s. per 1000 cubic feet, and £1029 for meter-rents at 3s. per year (which is our charge for an ordinary 3-light meter), leaving £2231 for hire of fittings and additional slot charges. This equals about 6s. 6d. per year, or 1¼d. per week, for each house. With 12,500 cubic feet registered on an average by each meter, and paid for at the

rate of 3s. 9d. per 1000 cubic feet, the excess payment, after deducting gas at the ordinary price (3s.), is 9s. 4d. for each house. I have taken the excess cost of fixing slot meter and fittings above ordinary to be—

Labour, pipes, and fittings	£2 0 0
Service	0 10 0
Slot attachment	0 18 0
Total	£3 8 0

The 10s. stated for service does not cover the cost, but represents the additional loss as compared with ordinary meters, the cost of the services to which are partly paid by the consumers. The 9s. 4d. yearly has therefore to provide—

(*a*) The extra cost of collecting and booking small accounts.
(*b*) Interest on £3 8s. capital, which, at 4 per cent., amounts to 2s. 9d.
(*c*) Rent of meter, which, for ordinary 3-light, is charged 3s.
(*d*) The attention to, and responsibility for, internal fittings, flexible tubes, &c., and the upkeep of the same.
(*e*) Finally, whatever sum is thought advisable to write off the value of the fittings, &c., from year to year.

This calculation of cost of supply and erection is based only on the excess cost for gas by slot meters, and is in every way independent of distribution in the ordinary manner. On the question of cost of collection and inspection, I shall speak later.

Acceptance of Orders.

One of the first causes of success in automatic gas supply is the careful selection of the class of property to be accepted. The ideal is the happy medium between villas and slums. We only give one description of fittings, and in not much variety; and houses of the better class—say, ranging from £30 rental upwards—are not generally profitable. When we have been induced to fit these up for a consumer, he has often been dissatisfied after the work is completed. For good and lofty rooms, better fittings than we supply are required; and although one consumer may be satisfied, on a change in the tenancy of the house we have been requested (sometimes not at all politely) to clear them away. Of course, loss is then incurred.

The best kind of house is undoubtedly that purchased, or being purchased, by the tenant, and inhabited by clerks, mechanics, or skilled labourers. These are not likely to remove, as a large proportion of our customers are constantly doing. They have an interest in the house, and in the keeping of it in

repair; and when once it is nicely completed, they will turn out excellent consumers, and give very little trouble. Workshops cannot be supplied satisfactorily by slot meter. The gas is not required as a rule except for a month or two in mid-winter; and during the remainder of the year the meter and fittings produce no profit, and, being in the way, are liable to damage. Orders for lighting stables should also be refused. The consumption is always small, and the fittings are likely to deteriorate. An eminent solicitor living in our district had his stables supplied by slot meter; and the money collected during a period of two years amounted to the magnificent sum of one shilling and sixpence. Small shops in our neighbourhood are good and large consumers—but troublesome, as they often change hands, and each incoming tenant requires alterations according to the nature of his business. On the other hand, when a good business man finds his shop a success, he generally prefers to change the system for a supply by ordinary meter.

It is becoming usual now, in closely populated districts, to erect suites of rooms in flats one above another, each portion a distinct tenement, but generally entered by a stairway or passage common to all. The automatic gas supply is suitable and easily furnished to such buildings; but care should be taken to place the service to all levels before the building is completed, and each meter should be placed, not in the common passage, where it is likely to be tampered with, but under the protection of the responsible consumer.

The fittings we supply consist of a 2-light chandelier, with cup-and-ball joint, but without hydraulic slide, and three pendants or brackets as required; one having an extra cock for the flexible tube and boiling-burner. The inspector who accepts the order carries a numbered photograph illustrating the fittings, to enable the customers to select from. He settles the position of the fixtures, and gets signatures to the consumer's contract, and the consent of landlord to fix and remove the fittings if required. The orders to place gas-fittings, after the meter is fixed by the Company's workmen, are handed to our contractors, who complete the fitting of each house at the agreed rate of one guinea per house for labour, pipes, &c., after which the work is examined, and if satisfactory the accounts are passed for payment.

Stoves.

As an experiment, our Company fixed without rent or charge, and in connection with slot meters, about 50 small gas cooking-ranges, to ascertain if the increased consumption of gas would

warrant any further outlay in the same direction. I think the subject of gas-cookers, and the different conditions under which they are provided by gas companies, is a question which up to the present has hardly received the attention it deserves. This matter may be partially beyond the scope of my paper; but stating the result of our experiment, and the opinion formed therefrom, will, I trust, call forth some very valuable remarks as the experiences of others on this subject.

Our experiment was a dismal failure. The excess consumption on an average was only about 2000 cubic feet per annum where the free cooker was placed, showing a return of 1s. 6d. in the extra or "slot" profit. The expense of obtaining and fixing these was over £2 each. Interest on capital alone would, therefore, more than absorb any profit from the increased consumption of gas, and leave nothing for depreciation, repairs, and changes. We have made no more experiments in this direction.

I cannot but compliment the manufacturers of gas cooking-stoves on the perfection which they have attained, and the wonderful economy with which the work is performed. But this very economy is an advantage in which the gas companies have no share. They bear all the heavy original outlay in purchasing and fixing, and afterwards the constant attention and repairing required; while the rental charges in many cases are scarcely sufficient to pay for the depreciation of a machine which is at once fragile and liable to injury. Gas cooking-stoves have so thoroughly established their utility, and are so generally recognized as the cheapest and most reliable means of domestic cooking, that some alterations in the present systems, whereby the expense is more equally divided, should not be a matter of great difficulty.

Collection.

Under the old system of collection, the boxes are emptied twice each quarter, and the proceeds paid directly into banks, of which we have eight branches in our district; each day's work being compared with the bank-slips, so that a good check is obtained on the collector and his collection lists. The necessity of paying in before closing of banks, however, makes the afternoon a short one; and fifty accounts were reckoned a good day's work. By this system, the collector had no cash to take home or leave at the office after his day's work was done.

Wishing to increase the number of collections each day, we have lately allowed some of our best men the opportunity to see what they could do at collecting on piece-work; the price paid being ¾d. per meter. Each man is given a district of about

800 accounts; and he is allowed to work his own hours, but is held responsible for the safety and correctness of his work. This has effected a great saving. The old system cost more than 8s. per 100 accounts. Under the new, the price is 6s. 3d. The collectors like the new plan, as it enables them, by working longer hours, to increase the amount of their wages considerably —especially where the banks are conveniently situated, and the neighbourhood thickly populated.

The collectors are provided with strong paper bags for coppers; each bag holding 5s., and stamped with the amount and the Company's name. It is a fact that for the last four years the banks have accepted these bags at the stamped value, and have supplied their customers with them without a single case in which the amount has been disputed.

This collecting work is heavy manual labour, and needs strong and vigorous men. Ten pounds' worth of coppers, with collecting bags and books, will weigh close on 56 lbs. The work is often dirty and disagreeable. Men are brought into contact with a good many family affairs that are usually kept in the background —with dirt, sickness, and sometimes death.

Concluding Remarks.

I have endeavoured, in this paper, to give some outlines of the conditions under which my Company have carried this now important branch of gas engineering to a successful issue. Many others, probably working in the same direction, have obtained better results; but, before concluding, I should like to remark on the satisfaction expressed by our customers, when they have once got acquainted with, and accustomed to, the system of lighting their houses by automatic gas supply. They seem almost to dread a return to their old plan of paraffin lamps, with the accompanying dangers and disagreeable smells. The owners of property and the agents who represent them are almost without exception in favour of our supply. They willingly assist by giving us notice of changes and removals. They consider the value of their property is enhanced, and the class of their tenants improved, by the introduction of the system. The houses are kept in better condition; and the constant inspection of collectors in uniform, who call so many times during the year, and who are necessarily invited into the interior of the house, must have its effect in bettering the conditions of the inhabitants, For where light is, cleanliness must follow and crime cannot hide; for the dark places of the earth are the habitations of cruelty.

Discussion.

The CHAIRMAN observed that the paper contained a great deal of interesting information; and some of it might be very useful. He was sorry to hear of the experience at Tottenham in regard to the hiring-out of cookers, because he believed it was quite opposed to the experience of a good many other companies. As to the remark Mr. Eldridge made respecting the stove makers, he (the Chairman) thought that he could quite endorse it. At all events, those buying gas-stoves should be very careful in making a selection. Some stoves were got up in a very trumpery way; and cost a great deal for repair at a very early stage of their use.

Mr. J. W. HELPS (Croydon) said he should like to thank Mr. Eldridge for having so kindly come forward to assist the Association with his paper. At the same time, Mr. Eldridge would excuse him for saying that he felt perhaps a little disappointed at the manner in which he had treated the subject, because it seemed to him it really resolved itself naturally into a question of £ *s. d.* What they wanted to know was whether this system, under the conditions in which it was worked in connection with their various companies, really paid its way. If the author, instead of giving them the figures in the way he had done, had worked them out at so much per 1000 cubic feet, the members could, having their own figures at their fingers' ends, have compared what they were doing in their own several towns with what was being done at Tottenham. He knew that it was the custom generally, when looking at the vast growth of the prepayment system, to consider it simply from the point of view of the number of consumers one had; but when one looked at it from the amount of gas, or rather the percentage which the quantity of gas used under the prepayment system bore to the total quantity, he thought then they would be somewhat surprised at the smallness of the proportion. At Croydon, where the system had been in use exactly ten years (in the town itself it was the prepayment system, and the automatic was only in use in one small district), he found that, in the year ending June 30, 1898, the total quantity of gas sold under the prepayment and automatic systems was only something like 13 per cent. of the total. This was accounted for by the fact that, while the average amount of gas used by a consumer under the ordinary system was 54,380 cubic feet, that used under the prepayment system was 18,311 cubic feet, and that used under the automatic system only 16,000 cubic feet. They had had a good

opportunity of comparing the two systems—the prepayment, whereby an amount of gas was turned on and paid for, and a receipt given by the inspector at the time of his visit, and the penny-in-the-slot, or automatic, system, to which Mr. Eldridge had more particularly alluded. In Croydon, under the prepayment system, they charged a regular rent of 2d. a week for the fittings, and under the automatic system the extra charge was 9d. per 1000 cubic feet. If the members would bear with him for a moment, he might point out how, from a pecuniary point of view, the three systems compared. In the first case, he found that the total amount of money which, in Croydon, was laid out on an ordinary consumer—that was, the capital outlay —was £2 18s. 5d. The gross amount there received for gas per 1000 cubic feet was 2s. 9·6d., including meter-rent. The cost of collection, 10 per cent. depreciation, and the various other charges (bad debts and inspectors), totalled to 2·28d.; leaving 2s. 7·32d. as the net amount received for gas—that was, with the charge of 2s. 8d. per 1000 cubic feet, only 0·68d. less than the actual amount charged. With the prepayment system, they found the total capital charge in Croydon, exclusive of a stove (because, the 2d. being a regular charge, and having nothing to do with the gas-stove, they could fairly charge the ordinary rent for the stove, which could not be done under the automatic system), was £4 9s. 9d. The gross amount received for gas, including rent, was 3s. 2·54d. The total charges for collection, 10 per cent. depreciation, inspectors, &c., came to 8·79d., giving them a net amount of 2s. 5·75d. In other words, they received 2·25d. less than the price of gas—viz., 2s. 8d. per 1000 cubic feet. Thus, they were actually supplying gas to the prepayment consumer in Croydon, at somewhere about 1¼d. less than to the ordinary consumer. Then they came to the automatic system, which was in use in the Carshalton district. There the capital charge, including a stove, came to £7 8s. 5d.; the stove in some cases being a large one, and sometimes costing as much as £5. They did not limit the cost of them, because their experience was different from Mr. Eldridge's. They found that the stove did very considerably increase the amount of gas used per consumer. In that district, the gross charge for gas under the automatic system was 4s. 2d. per 1000 cubic feet. Taking from this the various charges—1s. 2·15d.—left 2s. 11·85d.; and the ordinary price of gas in Carshalton being 3s. 5d., the amount received from the automatic consumers was 5·15d. less than they were charging the ordinary consumers. The cost deducted from the gross figure was rather raised by the fact that he had

taken 10 per cent. depreciation on a very large sum; but if he took the cost of the cooker away, it would be found that, practically speaking, it made a difference of about 4½d. upon the price charged to the automatic consumer, which was exactly the same as that charged to the ordinary consumer. But if they had not the stove, they would not have the gas; and therefore the divisor in that case would be smaller, and probably would bring it to just the same. This went to prove the fact that really the automatic consumer was treated rather too leniently. The 9d. per 1000 cubic feet did not really pay; and the ordinary consumers suffered accordingly. This did not appear to him to be quite fair. Going again to the question of stoves, he said it was a very important one, and one in which they were now taking a great deal of interest in Croydon, with the view of deciding whether it was fair to charge any rent whatever to the automatic consumer for the stove. He had taken out at random two instances that morning. In one case, a consumer on the automatic system in Carshalton was using, on an average, 59,000 cubic feet of gas in a year. Now, if they took these figures, and examined them carefully, it would be found that, deducting all charges from this man's account, he was paying the Company full rent for everything, and putting into their pockets 15s. besides, because they were charging him 9d. per 1000 cubic feet on the whole of the 59,000 cubic feet. Taking the case of another man only consuming 10,000 cubic feet a year, they found the Company were out of pocket to the extent of 5s. 6d. If, therefore, they went on charging the large consumer a rent for his stove, they would be making him pay twice over. He (Mr. Helps) would like to find out whether it was not possible to adopt some sliding-scale method, and not always take from the consumer 9d. per 1000 cubic feet, if he used a large quantity of gas. It seemed unfair to do so; and what he would like would be some system of regulating the extra charge per 1000 cubic feet according to the amount of gas burned. With their prepayment system in Croydon, charging regularly a rent of 2d. per week, it did not matter whether or not they charged rent for the stove. It was perfectly fair, one way or the other; and it was simply a matter for the Company to decide. He made these remarks because he wished to point out that so far this prepayment system had been wofully neglected. He believed, having had the two systems working side by side, that this one was absolutely the cheaper. In Croydon, 1·79d. per 1000 cubic feet covered cost of collection, while in the Carshalton district it cost 1·86d. It was usually thought that one of the

great disadvantages of the prepayment system was that the cost of collection was so much more than in the case of the automatic meters; but these figures rather disproved this. He wished to stand somewhat as a champion of the prepayment system; and he would ask those who were thinking of adopting one or other of the systems, to consider whether the prepayment system was not worthy of adoption in some towns.

Mr. W. E. PRICE (Hampton Wick) said he could quite bear out what Mr. Helps had stated with reference to cooking-stoves; but in his district they, of course, had nothing like the quantity fixed that there were in Croydon. His experience was that, unless the slot consumer had a cooker, he was not worth having. The slot consumers were charged the same proportion as rent; and, with the cooker, they found that, as Mr. Helps had said, it did not work out quite fair to the big consumer. In some cases the rent of the meter and cooker came to far and above what it should do; but it was difficult to know what to do under the circumstances. It hardly seemed satisfactory to have more than one price under the coin-meter system. It would cause great dissatisfaction; and besides they could not very well set the meter at one point for one consumer, who would probably disappear in a few months, and be followed by another whose consumption would necessitate a change again. He had not had any experience of the prepayment system of supply in use at Croydon; but his objection to it was one that had been raised by consumers using the shilling-in-the-slot meter. Where there had been a large amount of gas used, he had visited the consumer who had a shilling-in-the-slot meter, and he objected to it—his reason being that he could not control the consumption, and consequently did not obtain that economy with the shilling slot that he was able to secure with the penny slot, as he was unable to check the servant. It seemed to him (Mr. Price) that the prepayment system was even worse in this respect, because he took it that a man on the prepayment system would pay more than a shilling on each collection; and there was thus practically no check on the servants. In his district, the meters were in use for this object as much as for anything else. It was unlike Tottenham in that it was a residential district mainly, and had practically no labouring class population. Therefore, for the reason he had mentioned, the prepayment system would be much objected to by his class of consumers.

Mr. F. W. CROSS (Lea Bridge) said if their esteemed President had been with them that day, he would no doubt have put in a

word, following the remarks of Mr. Helps and Mr. Price, that would have explained the statement made by Mr. Eldridge in regard to the use of stoves. His (Mr. Cross's) district bordered on that of the Tottenham Company; and he could quite believe Mr. Eldridge when he said that stoves were not suitable there in connection with the slot-meter system. The class of people who used these slot meters there was quite different to what would be found in Mr. Price's neighbourhood, where they would take the stoves. He thought in his own district stoves would not be suitable, because he would get exactly the same class of consumer as they had in Tottenham. However, from his present experience, he thought he should do better by leaving stoves alone; and the only thing he would push with his consumers would be boiling-rings. He believed these were the most suitable; and perhaps he might put in a small griller for use in the early mornings. He thought the point as to the class of consumer should be borne in mind in considering Mr. Eldridge's paper; and it should not be said that, because Mr. Eldridge had found that stoves did not pay, they would not pay anywhere else. There was only one little point he should like to put to Mr. Eldridge. He said: "On the other hand, when a good business man finds his shop a success, he generally prefers to change the system for a supply by ordinary meter." Now, as he (Mr. Cross) had said, he had not gone into the slot-meter business. With an increase of 20 to 25 per cent. per annum, he thought he was better without it. They had, however, a system of monthly supply and collection; and they furnished fittings on hire, and charged a rental of so much per week. He should like to know from Mr. Eldridge what he did in regard to the fittings left in houses, when a consumer changed to the ordinary supply.

[At this point, Mr. Morton had to leave the meeting, and the Vice-President (Mr. D. Irving) thereupon took the chair.]

Mr. W. B. RANDALL (Waltham Cross) said he noticed the author mentioned that, to facilitate collection, they had started a piece-work system. It occurred to him (Mr. Randall) that this was possibly liable to be false economy, for the reason that, in collecting from slot meters, there were oftentimes little trivial things that could be attended to by the slot-meter collector. But if he was on piece-work, his natural inclination would be to make marginal notes in his book; and then a fitter would have to be sent to attend to them, and this would add to the cost of the system. He had had considerable experience of slot meters; and, like Mr. Helps, he found stoves did pay them

very well indeed. They were now in the position of having 140 to 150 per cent. more automatic meters than ordinary ones, and he was sure their increase of consumption had been very largely helped, both in the automatics and ordinary meters, by the cookers. They found in many cases where people started with the automatic meter, that they changed after a time to the ordinary meter; and it caused an introduction in this way which otherwise they might not have had. He found that a boiling-ring, too, frequently led to the adoption of a stove. The consumer wanted greater facilities; and then they supplied him with a stove. The stoves had answered very well indeed. Naturally the character of the district had to be considered. What might be unsuitable in Croydon was very suitable in the vicinity of Tottenham; and where there was an artisan population, the automatic system was undoubtedly a great success.

Mr. F. G. Cockey (Newport, I. of W.) said, as contrasted with Mr. Humphrys' paper, this contribution of Mr. Eldridge's was a most interesting one, and bristled with matter upon which every member would possibly form a different opinion from his own experience. Personally, with reference to the remarks about cookers, he had had to fit up houses on the slot system as opposed to the prepayment system Mr. Helps had mentioned; and he had come to the conclusion that the cooker was a necessary part of the fittings—that, without a cooker, the slot system was hardly worth having. He might say they confined themselves to one pattern of cooker—small and strongly made—but it was rather early to speak about what the life of the cookers would be, because he had not seen one perceptibly the worse for wear, except for dirt. Speaking of cookers of larger size, even after ten or twelve years' use he had not seen one worn out. Although he had not been able to get figures to show what the maintenance worked out at, he was quite convinced it would be very small. There was a question that had presented itself to him, and no doubt to others, as to how these cookers and other parts of the free fittings should be treated—whether a portion of them should be charged to capital. It seemed to him to have rather an important bearing upon the apportionment of the excess charged on the slot meters. His idea was that the cookers, which were permanent and durable fittings, should be charged to capital. In his own case, they charged the meter and services direct to capital; and he thought the cookers should also be charged to capital. He took it that the amount of maintenance required by them would be a very small addition to the ordinary maintenance charges to revenue. With

reference to Mr. Helps's remarks in regard to his experience at Croydon, one had, of course, to take into consideration the local circumstances. Croydon was one of those places where the majority of the people earned good money; and it was probable the prepayment consumers readily planked down 5s. or even 6s. [Mr. HELPS: No; 1s. or 1s. 2d.] But in a town like his own, where the population was decidedly poor, it was very difficult to get people to pay for anything in advance. They were perfectly willing to pay a penny; but they would not pay out a shilling if they could help it. But this, of course, was a matter of local circumstance. As to the question of limiting the size of houses fitted up, their limitation was houses of £20 rental.

Mr. W. B. MIMMACK (St. Mary Cray), speaking with an experience of 500 automatic meters, said he could not help thinking that the whole question was one of margin. Automatic meters could be made to pay if a sufficient margin was left for the purpose. Some years ago, 8d. or 9d. was suggested as a figure that was ample to cover everything; but it was not sufficient if cookers were put in. Experience had proved that the automatic system without a cooker was not worth having. In his district, the cooker was the one thing that was necessary to make the automatic installations (if he might call them so) a success. But he found that the cookers required a good deal of attention; and every now and then they saw that they were not used so well as they should be. The cookers had then to be taken out, and sent up to the makers, in order that they might be repaired. This entailed a considerable outlay; and therefore, in order to cover what looked like being rather greater expense than was generally anticipated, they allowed a larger margin than was usually adopted. He thought Mr. Helps said that he found the automatic consumer was being treated to the tune of 5d. per 1000 cubic feet better than the ordinary consumer. He (Mr. Mimmack) found that this was just about the figure—that was, between 9d. and 1s. 2d. was the figure that should be taken. In his case the ordinary consumers were charged 3s. 10d. per 1000 cubic feet, and the automatic consumers 5s.; and they found they had only just sufficient to cover the expense of depreciation and the interest on the money laid out. He might say, too, when they first started they had a rush of undesirable applicants—people whom they felt sure would never make the system a success. They therefore cast about to find a means of choking off the worst; and they ultimately decided to fix an application fee—only a low one—and to make a distinction between those who were applying simply

for lighting and those who were asking for cookers, because the Company were anxious that they should take care of the cookers, and not go in for them when they only wanted a light in the kitchen or scullery. Therefore it was decided to charge a fee of 1s. to applicants who did not require a cooker, and 2s. 6d. to those who did. This had acted in a most satisfactory manner; and the results they were getting from the consumers who paid 2s. 6d. were infinitely better than the results they obtained before the application fee.

Mr. W. F. BROADBERRY (New Southgate) asked Mr. Eldridge how he arrived at the excess consumption of 2000 cubic feet per stove. He happened to be managing works on the borders of Tottenham; and the paper was therefore of particular interest to him. He understood that at Tottenham, they simply fixed fifty stoves as an experiment, and they did not really know what these particular meters would have done without the stoves. It seemed to him that, if they had put the fifty stoves on to customers who were already burning gas through slot meters, and then compared the consumption of gas under the two conditions, Mr. Eldridge's figures would have gone a bit farther than they did at the present time. At Colney Hatch, they had been putting out automatic meters for four or five years; and they fixed cookers as well. In most cases, he found the consumption by them was more than 2000 cubic feet; it was, he thought, much nearer 10,000 feet. Regarding the difficulty as to the size of the stove, they only in the ordinary way used a small stove, for which they paid the makers ab out 25s. These stoves met their own requirements and those of their consumers; and not many of them wanted a larger one. They also let stoves in the ordinary way, and made a charge of 2s. to 3s. 6d. a quarter. If a slot consumer wanted a larger stove, they told him that they regarded his stove as worth 1s. a quarter; and if he had the size rented at 3s. 6d., he must pay 2s. 6d. more for it. The consumer would do so; and they got over the difficulty.

Mr. F. G. DEXTER (Winchester) said, with reference to the point raised by Mr. Price as to the difficulty of introducing shilling slot meters instead of penny ones, this was not his (Mr. Dexter's) experience at all. He had had cases where the consumers had had some difficulty in placing in the meters the number of pennies they required to; and they had applied to the Company for shilling slot meters in order to save trouble. This point showed how impossible it was to always apply the experience of one man to another's case, and particularly was this evident in the question just raised by Mr. Helps. He

(Mr. Dexter) noticed that it had been stated three times already during the discussion that prepayment consumers were not worth having, unless they had a cooking-stove. He recognized this point so strongly at the commencement of their slot-meter career about five years ago, that he had done his best to get nothing but cooker consumers; and four-fifths of those he had were only cooker consumers, and without lights at all. They paid exceedingly well. As to the objection raised by Mr. Helps regarding consumers having to pay a heavier rate for the cooking-stoves by the automatic system in consequence of the quantity of gas being set at so many feet per penny, if they happened to set the meter at such a rate that the rental was being practically paid twice or three times over, they were doing that man an injustice. At the time he (Mr. Dexter) occupied the chair of the South-West Association, he distinctly mentioned in his Inaugural Address that he strongly objected to the system of an extra charge for prepayment consumers at all; and he had worked entirely upon the principle of having the prepayment consumers on the same rates as the ordinary consumers, taking into consideration the amount of rent the latter had to pay for their meters, and setting the slot meters at the number of feet per penny which they judged would pay the rent. If it was found that they had not allowed quite enough, the meter was corrected, and if they had allowed too much, it was also corrected; and, at the end of a quarter, they returned whatever surplus there might be to the consumer. Cooker rents were paid quarter by quarter to the inspector as he went round; and the consumers were allowed to have any sized cooker they chose, from 1s. to 4s. 6d. By these means every slot consumer was placed in exactly the same position as the ordinary ones. He paid no more and no less, so far as they were able to manage it, than the ordinary consumer who had gas for lighting purposes only.

Mr. IRVING said that whatever differences of opinion there might be—and there were evidently great differences of opinion and great differences of experience with regard to slot meters—he thought they were all agreed that the Tottenham Company had been very successful in the letting out of these slot meters. So far as he was able to judge, the whole matter resolved itself into the question: Does it pay? He ventured to think that the system of fitting up lights and cookers, and letting out slot meters, as it stood by itself on the figures given, did not pay in the long run. If they took the figures, they worked out something like this: There was an income of

£16,000, from which the gas at the ordinary rate was taken and the meter-rents deducted, leaving the sum of £2231 to cover the interest on the large capital expenditure, the extra cost of working (because he thought there must, without any doubt, be an extra cost), the wear and tear and renewals, and some amount of depreciation ought to come in. Now, he ventured to think, upon the number of meters mentioned in the paper, the sum of money available would not cover the items he had named, presuming they allowed 5 per cent. interest. On the other hand, it must be clearly understood that there was a large profit accruing to the Tottenham Company from the sale of the 85 million cubic feet of gas at 3s. per 1000 feet. This profit, assuming the system was made to pay its way—that was, that the amount of extra charge was sufficient to cover the cost of interest, maintenance, &c. (and maintenance must be understood in the sense in which it was understood in gas accounts—that was, to cover depreciation), then the Tottenham Gas Company stood well with regard to the system, because in the ordinary way they would have between £2000 and £3000 profit from the gas. Therefore this system of prepayment meters was worth carrying out. The only thing was to take care that they did not unduly increase the capital; and he thought every company going into the system to the extent the Tottenham Company had done should clearly and definitely set aside a certain annual amount to wipe off the capital in a fixed period. He did not think any manager or official of any company would be justified in entering into this large capital expenditure without doing something to wipe it off.

Mr. ELDRIDGE, in reply, said he stated distinctly in the paper that his calculations were based on the excess price of gas only, and not on the 3s. per 1000 cubic feet. The Directors had already transferred from capital to a suspense account the cost of all the fittings fixed. Where a consumer changed from a slot to an ordinary meter, they generally got him to pay a rental of 2d. per week, or buy the fittings at a reduced rate. They never allowed the collectors to do anything in the way of repairs; proper officials being sent, on a report being made to the office. With regard to the fifty cookers, they made the comparison with the average of fifty consumers without cookers; and they so arrived at the 2000 cubic feet excess consumption. Speaking of cooking-stoves, they had had to revise their list of charges. They had had them as low as 1s. 3d. per quarter; now the lowest was 2s. 3d. per quarter—the list price running from 9s., to 12s., 15s., and 18s. per annum.

Mr. IRVING thought the consumption of 12,500 feet per meter was above the average, with the exception of Croydon.

Mr. DEXTER said his average was 18,000 feet.

Mr. BOTLEY; And mine is also very much more.

Mr. IRVING remarked that, in a return published last year, the average did not reach 10,000 cubic feet.

On the motion of Mr. J. TYSOE (East Greenwich), seconded by Mr. W. D. CHILD (Romford), a hearty vote of thanks was passed to the authors of the papers, who both responded.

The business then closed.

Before separating, the members had tea together.

MANCHESTER INSTITUTION.

QUARTERLY MEETING, NOV. 25.

This Meeting was held at the Midland Hotel, Bradford—Mr. R. G. SHADBOLT, of Grantham, the President, in the chair.

THE LATE MR. GEORGE ERNEST STEVENSON.

The PRESIDENT said his first duty was of rather a melancholy character. Before proceeding to the strictly business part of the *agenda*, he would ask the members to pass a vote of condolence with the widow and family of the late Mr. George Ernest Stevenson, of Manchester, whose worth and kindly disposition were known to all the members. Mr. Stevenson was the Senior Vice-President of the Institution; and, had he lived, he might soon have filled the office of President. The melancholy circumstances of his death were greatly to be deplored.

Mr. C. WOOD (Vice-President) seconded the proposition.

The vote of condolence was carried unanimously—the members rising in silence.

The HON. SECRETARY (Mr. S. S. Mellor, of Northwich) having read the minutes of the previous meeting, they were unanimously adopted.

The PRESIDENT then called attention to the fact that they were honoured by the presence of Mr. Doig Gibb, the President of the North of England Association of Gas Managers, and Mr. Wimhurst, the President of the Eastern Counties Association; and he expressed the hope that these gentlemen would take part in the discussion of the papers.

MEMORIAL TO THE LATE MR. STEVENSON.

Mr. R. PORTER (Elland) said no doubt it was generally known to the members that it was proposed that there should be a memorial to the late Mr. Stevenson;* and, as this was to be of a national character, it was thought desirable that the Institution should be represented on the General Committee. He would

* The proposal referred to was made by Mr. H. E. Jones, in a letter to the *Journal of Gas Lighting* for Nov. 21, 1899.

therefore propose that the President and the Secretary be nominated to serve thereon.

Mr. T. N. RITSON (Kendal) seconded the proposition, which was carried unanimously.

ELECTION OF MEMBERS.

The following new members were duly elected: Mr. H. J. Robinson (Mossley) and Mr. T. D. Overing (Birstall).

ELECTION OF PRESIDENT.

The PRESIDENT said the Council were placed in an unfortunate position owing to the death of their Senior Vice-President, and by the inability of Mr. Wood to take the chair; but he was happy to say that a gentleman had come forward who, he felt sure, would fill the office with credit—viz., Mr. Ritson, of Kendal. Those who were present at the meeting in May, when Mr. Ritson was their host, would remember the way in which he had catered both for their creature comforts and their intellectual welfare. He therefore proposed that Mr. Ritson be elected President for the ensuing year.

The HON. SECRETARY said it afforded him great pleasure to second the resolution. Mr. Ritson had been called upon at very short notice; and he (Mr. Mellor) desired to thank him for having consented to take office.

Mr. WOOD supported the resolution. He thought it was due to the Institution that he should give his reasons for not accepting the office. The Corporation of Bradford, as the members were aware, had a rather ambitious scheme on foot; and during the forthcoming year his time would be so fully occupied with this matter, and with extensions that were about to be carried out in the gas-works of which he had the management, that he felt it would not be to the interests of the Institution that he should take the presidentship. He was sure Mr. Ritson would make a first-rate President.

The resolution was passed unanimously.

Mr. RITSON, in returning thanks for his election, said he accepted the position with mingled feelings of pleasure and regret—pleasure, in that the members had done him the honour of thinking him worthy to be their President; and regret that he was called upon under such melancholy circumstances. The late Mr. Stevenson was a gentleman for whom he had the highest regard; and the many kindnesses which he had received at his hands would ever be present to his memory. He also regretted that Mr. Wood was unable to take the chair; but they would all sympathize with him in the circumstances which prevented

him doing so. He (Mr. Ritson) was equally pressed in his own business; having two Provisional Orders before Parliament. His hands were therefore very full; and if he failed to discharge the duties of the presidency as well as many able men had done in the past, he hoped the members would forgive him. He had a good Council to work with; and he hoped his year of office would be an agreeable one to all the members.

Reading of Papers.

Mr. Thomas Newbigging (Manchester) read the following paper:—

SOME DISPUTED POINTS IN GAS AND WATER WORKS LEGISLATION.

I.—The Proper Amount of the Reserve Fund.

II.—The Position of Certain Companies Working under a Provisional Order as regards their Borrowing Powers.

My paper on this occasion is rather out of the usual run of technical papers submitted to a Gas Association for discussion. But it is only another exemplification of the fact that the gas manager of to-day has to be a good all-round man.

There are a number of minor points in gas and water legislation on which differences of opinion exist on the part of Counsel learned in the law, and also of those whose duty or privilege it is to give evidence on Bills before Parliamentary Committees. The latter, being chiefly laymen, do not, as a rule (though there are exceptions), pretend to interpret the law; but when they venture so far—as occasionally they do, being to some extent justified by their long experience in the corridors of Westminster, and by their study of the Acts of Parliament—their unlearned opinion can only be taken for what it is worth. You remember the apt saying: "The man who is his own lawyer has a fool for a client." That a man should be his own lawyer is a piece of advice the wisdom of which, to say the least, is questionable. I am not inclined to adopt it myself; and I do not recommend its adoption by others—remembering that a little learning is a dangerous thing.

My excuse, however, for venturing to deal with these disputed questions at all is that most of our laws are made by men who are not lawyers themselves, but are gifted (many of them) with a large measure of common sense and business capacity; and, that being so, it is surely permissible for the layman to try and settle exactly what was the mind and intention of his brother laymen who framed those particular laws. But even if that

were otherwise, an expert is perforce compelled to be half a lawyer. Indeed, from the very vantage ground of his standpoint, he is able sometimes to perceive, more clearly even than does the purely legal mind, the practical bearings of certain subjects.

It is not my intention on this occasion to speak of the numerous minor points of difference to which I have referred (though there is here material for many a good paper), but rather to select two matters of primary importance on which to offer comment. I propose, accordingly, to take the following points, which are of very considerable interest for those having to do with the administration of gas-works, and incidentally also of water-works undertakings. These are—

1.—As to the amount of the reserve fund to which a statutory gas or water company are entitled, under the Gas-Works Clauses Act, 1847, and the Water-Works Clauses Act of the same year.

2.—As to the borrowing powers of certain gas and water companies having Provisional Orders under the Gas and Water Works Facilities Acts, 1870 and 1873.

First, then, as to the sum of the reserve fund. Gas companies working under the sliding-scale of price and dividend—that is, with a standard price of gas and a standard rate of dividend—are, as is well known, without limit as to the amount of reserve which they may accumulate, always provided that such reserve is made up out of profits which the Company are entitled to divide among the shareholders. That is to say, assuming a company are entitled under the sliding-scale to divide 11 per cent., and they elect to divide 10½ per cent., the sum representing the ½ per cent. difference may be carried bodily to the reserve fund. Sliding-scale companies are, in fact, exempted from the operation of the provisions relating to the amount of profit to be received by the undertakers—viz., clauses 30 to 34 inclusive, of the General Gas Act. About that there is no conflict of opinion whatever; and therefore these may be put aside.

It is the reserve fund of companies having a maximum price and dividend, which they are not allowed to exceed, that we have to discuss to-day. If we turn, then, to section 31 of the Gas-Works Clauses Act, 1847, and section 76 of the Water-Works Clauses Act, 1847, which are incorporated in the Private Acts of all statutory gas and water companies respectively (remembering, of course, as I have already said, that sliding-scale gas companies are exempted from the operation of clauses

30 to 34 of the Gas-Works Clauses Act, 1847), we find that it reads as follows:—

If the clear profits of the undertaking in any year amount to a larger sum than is sufficient, after making up the deficiency in the dividends of any previous year as aforesaid, to make a dividend at the prescribed rate, the excess beyond the sum necessary for such purpose shall from time to time be invested in Government or other securities, and the dividends arising from such securities shall also be invested in the same or like securities, in order that the same may accumulate at compound interest until the fund so formed amounts to the prescribed sum, or, if no sum be prescribed, a sum equal to one-tenth of the nominal capital of the undertakers, which sum shall form a reserved fund to answer any deficiency which may at any time happen in the amount of divisible profits, or to meet any extraordinary claim or demand which may at any time arise against the undertakers; and if such fund be at any time reduced, it may thereafter be again restored to the said sum, and so from time to time as often as such reduction shall happen.

This seems clear enough at first sight. But when we come to look into it more closely, and try to interpret it, there is room for difference of opinion as to what it implies. This difference hinges upon the meaning which is attached to the expression "nominal capital"—the reserve may be "a sum equal to one-tenth of the nominal capital." Now, what is the nominal capital? There are those who contend that it includes the whole of the capital, both share and loan, which by their Special Act the company are entitled to raise. Others, again, assert that it is the amount of capital issued, whether it is all paid up or not; while others hold that the nominal capital is the actual paid-up capital of the company. Manifestly, the sum accumulated as a reserve fund will vary according to the interpretation which is given to the words of the clause. For example, a company may be entitled under their Act to raise, say, £200,000 by shares or stock and £50,000 by borrowing—together £250,000. Ten per cent. on this amount as reserve is £25,000. The company, however, may only have issued £100,000 stock and borrowed £25,000. On this amount, a 10 per cent. reserve would be only £12,500. Again, it may be that £75,000 only is paid up, and no borrowing powers exercised. A 10 per cent. reserve on this would be £7500. So that, according as the words of this section of the Act are interpreted, the reserve fund of this imaginary company may be £25,000, or £12,500, or £7500.

The question then is: Which sum is the proper one? They cannot all be right. Everything hinges, as I have already said, on the true meaning of the words "nominal capital." My view is that the words intend only the share capital or stock actually

issued and paid up. That is to say, the nominal value of the capital as distinguished from its market value, which latter may be, and usually is, in the case of 10 per cent. stock, more than double the nominal value.

The total capital which the company are entitled under their Special Act to raise is not nominal capital, but "authorized capital;" and it is so described in Schedule B of the Gas-Works Clauses Act, 1871. In corroboration of this view, consider the spirit as well as the letter of the section. It is distinctly stated that the purpose of the reserve fund is "to answer any deficiency which may at any time happen in the amount of divisible profits." This being so, it is clear that nominal capital must mean the actual subscribed or paid-up capital, because capital issued but not paid up does not carry any dividend, and therefore there is no dividend to equalize. So, again, with authorized capital not issued. No dividend is payable on that, and therefore there is no deficiency to answer in respect of it. *Ergo*, nominal capital in the Act means capital subscribed or paid up and entitled to dividend; and it cannot mean either capital issued but not paid up nor authorized capital unissued.

But the section provides further that, besides equalizing dividends, the reserve fund is "to meet any extraordinary claim or demand which may at any time arise against the undertakers." It is impossible to forecast what any extraordinary claim might amount to. The chances are against its being any such amount as could not be met out of the reserve; and so I still hold that a reserve fund equal to one-tenth of the actual paid-up capital is what is meant both by the letter and spirit of the Act.

It is quite true that section 30 of the Gas-Works Clauses Act, 1847, and section 75 of the Water-Works Clauses Act, 1847, both mention paid-up capital as being the capital on which dividend is to be paid; and it might be inferred from this that there is a distinction between this paid-up capital and the nominal capital spoken of in the subsequent clauses, 31 (gas) and 76 (water). But, as I have already remarked, the spirit of the section, as well as the letter, which defines the object of the reserve fund, needs to be considered.

Again, in the insurance fund clause introduced into all Special Gas Acts containing the sliding-scale of price and dividend, the sum allowed to be set aside is stated to be one-twentieth of the "paid-up capital" of the Company. It might appear from this, also, that the very fact of the paid-up capital being specifically named is a differentiation in principle from the term

"nominal capital" employed in regard to the reserve fund in the Acts of 1847. But I do not hold that view. My opinion still is that the two expressions mean one and the same thing; but the vagueness of the term "nominal capital" having been recognized, it was decided to use the clearer and more definite description "paid-up capital" in the later insurance clause.

It is urged that, in registering a company under the Companies Acts, 1862-67, the expression is "nominal capital," and the registration fees are charged upon the authorized capital. That is so, no doubt; but the term nominal capital here is a conventional expression. The case of a statutory company under the General Act is altogether different; the reserve being restricted in its objects.

I know various instances where the administrators of gas undertakings—directors and others—have taken it upon themselves to interpret the law in this particular, and to raise the reserve fund to 10 per cent. of the authorized capital. These may be inclined to resent my dealing with the subject in this public manner—partly on the principle that sleeping dogs are best let lie, or that, as concerns themselves, where ignorance is bliss 'tis folly to be wise. I cannot, however, accept this dictum; believing, as I do, that it is desirable in every way that fairplay as between both consumers and shareholders should prevail. I admit, however, that there is room for difference of opinion on the question; and it is much to be desired that an authoritative decision of the Superior Courts were given on the subject.

So much for the reserve fund. The other point with which I propose to deal is not of as wide interest as that of the reserve fund, because it concerns only a very limited number of companies; but, as affecting the interests of these, it is well worth considering for a few minutes. I refer to the borrowing powers of certain companies (whether gas or water) working under a Provisional Order in the absence of a Special Act.

When a non-statutory company seek for statutory powers by means of a Provisional Order under the Gas and Water Works Facilities Act, 1870, they must first be registered under the Joint-Stock Companies Act, 1862-67. This latter Act regulates the action of all such companies, even after they have obtained a Provisional Order, except where such Order expressly otherwise provides.

It so happens that from 1870 (the year when the Gas and Water Works Facilities Act was passed) down to, and inclusive of, 1877, none (or, if any, not more than one or two) of the Provisional Orders granted to the newly-incorporated companies

contain provisions as to borrowing powers. The conclusion very widely drawn from this was that borrowing powers could not legally be exercised by such companies. This was an entire misapprehension.

It was shown very clearly in the session of 1897, when the Bill of the St. Anne's-on-the-Sea Urban District Council for the purchase by compulsion of the St. Anne's-on-the-Sea Gas Company's undertaking was before Parliament, that the Company possessed unlimited borrowing powers under their Memorandum of Association. The credit for making this clear is primarily due to Mr. John Woodcock, of Haslingden, the Gas Company's Solicitor, to whose energy and ability, also, the eventual defeat of the District Council's Bill was largely due.

As a matter of fact, the Act of 1862 puts no limit on a company's power to borrow; and unless a Provisional Order subsequently restricts the power, it can be exercised to such extent as may be prudent on the part respectively of the borrower and lender. All (or nearly all) the companies incorporated by Provisional Order between 1870 and 1877 are in that position, with their borrowing powers unlimited. I am not arguing that this power is a good and desirable one for a company to possess. Probably it is not, and Parliament has seen fit since 1877 to restrict the power of companies in this respect, by invariably inserting a limiting clause in the Order.

It is well, however, to know the facts. To show how little they were known and appreciated before the proceedings on the St. Anne's-on-the-Sea Bill took place, it may be noted that more than one distinguished Counsel scouted the "Country Solicitor's" law on the point (even Barristers, it seems, are not infallible), and more than one expert was willing to stake his reputation that the said Solicitor was wrong. We know that the "Country Solicitor" was perfectly right.

Discussion.

The PRESIDENT said the paper was rather out of the usual run of the technical papers that were submitted to the Institution for discussion; but it was only another exemplification of the fact that the gas manager of to-day needed to be a good all-round man. Mr. Newbigging stated the points at issue very clearly indeed, and had given a very lucid explanation of the word "nominal." If any member present was connected with a Company who had unlimited borrowing powers, he would be able to add a little to the information brought out by the "Country Solicitor" referred to by Mr. Newbigging.

Mr. H. KENDRICK (Stretford) said he represented a Company who worked under clause 34 of the Act of 1847. So far as his Company were concerned, they did not proceed altogether on the lines stated by Mr. Newbigging. They certainly took a reserve fund of 10 per cent.; but they reckoned it on the share capital, and not upon the share and loan capital together. Their Solicitor advised that this was perfectly in order; and, as Mr. Newbigging knew, their Solicitor was a member of a very well-known firm in Manchester. Not many months ago, the question cropped up as to whether they were not entitled to raise the reserve on the loan capital as well; but that was vetoed. They strongly opposed the idea that they were only entitled to raise the reserve fund on the issued capital. The capital of his Company stood nominally at £10,000; and up to last year they would only have been able to raise the reserve on some £8000. Fortunately, it had not been necessary for them to dip into the fund very largely in past years; but he could foresee that a time would come when the difference between what Mr. Newbigging said it ought to be—the share capital actually issued and paid up—and what the capital stood at, would be a matter of importance to the Company. His Company disputed Mr. Newbigging's dictum upon this point. Under their new Act (which they obtained last session), they had power to raise another £150,000 of capital; and their lawyer informed them that they would now be able to have a reserve fund—if they cared to put it into force—amounting to £25,000. Their paid-up capital in all amounted to £100,000; so that the difference between what Mr. Newbigging said and what their lawyer advised them they were entitled to raise the reserve fund to, would be represented by the difference beween £10,000 and £25,000. Then, again, he could not see why the reserve fund should not affect the authorized capital. They certainly did not pay dividends on loan capital. They paid interest, which, although it was not called part of the profits, was so in reality; and if they were at liberty to dip into the reserve fund to pay dividends why should they not be at liberty to dip into it to pay interest. It was capital, and they had to make profits to pay it. To his mind, this point required clearing up quite as much as the one mentioned by Mr. Newbigging. With regard to the insurance fund, they had succeeded in getting one through, but, instead of being limited to one-twentieth of the paid-up capital, the Chairman of the House of Lords Committee had kindly cut it down to one-fiftieth.

Mr. R. PORTER (Elland) said he did not think he could add

much to the discussion, as Mr. Newbigging had so clearly defined what was meant by "nominal capital" and "authorized capital." One point which might be discussed was as to what was a desirable amount for a company to have in their reserve fund. They all had experience of what was necessary for a company, and how often they had to go upon the reserve fund to make up their maximum dividend; and some of them had experience of what became of the reserve fund in the event of compulsory purchase. He did not believe it was a very desirable thing to accumulate a reserve fund up to 10 per cent. of the capital of a company—that was to say, a company whose income was pretty well assured, and whose business was progressing; nor did he think the company in the end very much benefited, especially when it came to a question of compulsory purchase, and the people taking them over took over the reserve fund as well. There were not many representatives of companies present that day who had to call upon the reserve fund to make up a deficiency in their dividend. In fact, he thought that the majority were inclined, when there was an adverse time—such as a coal strike, which raised the price of coal above its normal value—rather to pay a less dividend than go to the reserve fund. Therefore, why should they pack up the reserve fund to make it 10 per cent. of the authorized capital? He should be glad to be informed on this point.

Mr. T. BOWER (Hartlepool) said in the case of statutory companies no provision whatever was made for a reserve fund, but that instead a floating balance was carried forward year by year. His Company had no reserve fund whatsoever, and no special power to raise one.

Mr. NEWBIGGING said if the Company's Act incorporated the Act of 1847, no special power was needed.

Mr. BOWER said they were advised by their Solicitor that they had no power to raise a reserve fund; but they had a floating balance which answered the same purpose. He knew beforehand that it would be said the case was an exceptional one; but he should be very glad to have the benefit of Mr. Newbigging's experience on the point.

Mr. J. WILKINSON (Drighlington) asked why the loan capital should not be included in the paid-up capital when getting the proportion of the dividend. As Mr. Kendrick had said, interest had to be provided even before dividend. Therefore, seeing that they had to provide the interest, surely it must be essential that it should be taken in as the capital value or the paid-up value of the company. With reference to Mr. Porter's remark,

that there should be no reserve fund, all he could say was that he was in a very fortunate position if he could in times of strike pay a 1 or 2 per cent. less dividend, and yet have his shareholders come up smiling. With reference to the suggestion that the reserve fund might be swindled out of what it was entitled to, the remedy would be to take it out of the company's hands, and put it into Government securities; and then perhaps the local authorities might not have such a hold upon it.

Mr. ISAAC CARR (Widnes) said he felt very much indebted to Mr. Newbigging for his paper, by means of which the members would be able to save the "nimble six and eightpence." The legislation applying to some municipal works was very peculiar. By their own Local Act at Widnes, they were not empowered in any way to raise a reserve fund or to have a floating balance, as he understood—that was to say, they were unable to help one year out of the profits of another. Any surplus that they made in one year must go in reduction of price, and each year's working must stand by itself. He had many times thought it would be a good thing for them if they were able to put a little money on one side to meet times of adversity. Perhaps Mr. Newbigging, in his reply, would say whether, incorporating the Act of 1847, as they did, they would be entitled to raise a reserve fund under the name of a floating balance.

Mr. T. N. RITSON (Kendal) said he represented a Municipality which had taken over both gas and water; and in their Acts it was distinctly stated what the amount of their borrowing powers should be. So that, in their case, the Government had legislated on their behalf. He did not know whether this was a new phase which had come over legislation.

Mr. C. WOOD (Bradford) was not quite sure as to what their powers were in Bradford with regard to a reserve fund; but they had large funds which were, for all practical purposes, reserve funds. One was called a restoration fund; and at the present time they had a floating balance of over £50,000, though he thought their Acts were very similar to those appertaining to Widnes. He did not know that it was policy even on the part of a corporation to have a very large reserve fund. He found that it caused other departments to cast envious eyes upon it; and they usually wanted to help in the spending of it. He did not know that in Bradford they were protected very much by the amount of their reserve fund. He should like to hear what Mr. Newbigging had to say to the position of the reserve fund when a gas company was taken over by a corporation. He wished Mr. Newbigging had treated this subject

first, because the Bradford Corporation would be coming before Parliament very soon, when he supposed they would have Mr. Newbigging opposing them tooth and nail.

Mr. G. NIVEN (Cleckheaton) did not think that corporations wanted any reserve fund at all, as they always had the rates to fall back upon. If he represented a company, he should not care to have any reserve fund; he would pay it all away to the shareholders. He would not give any corporation the chance of taking it away from them.

Mr. H. TOWNSEND (Wakefield) asked if it were obligatory on statutory undertakings to invest their reserve funds in municipal loans, 3 per cent. stock, or any other approved securities. He noticed last year that one company who were before Parliament had used their reserve fund as working capital. He did not know whether this was legal. Another thing he should like Mr. Newbigging to touch upon (as he was giving advice gratis that afternoon) was with regard to the suspense account—whether, if any undertaking appropriated money to a suspense account, this suspense account must be liquidated out of revenue, or whether the amount could be left to be dealt with hereafter in whatever manner the company wished—that was to say, whether they could allocate some to capital and the rest to revenue, or whether it must all go to revenue.

The PRESIDENT said the discussion had been highly satisfactory. He could not help thinking, when Mr. Porter was advising them to do away with the reserve fund, of that very wonderful balance-sheet which Mr. Porter laid before his shareholders—which was not content with a reserve fund, not content to capitalize that reserve fund for their own use, but went into insurance funds of all kinds, besides a floating balance. With regard to the reserve fund, he had often thought that, whether it was taken as meaning the authorized capital or as the capital actually raised, it was equally unfair. Sometimes their nominal capital bore a 10, 7, or 5 per cent. rate of interest, and their loans 3 per cent.; and it would be much better and fairer if the total amount paid in dividends and interest were made the basis for estimating the reserve fund.

Mr. NEWBIGGING said the discussion had furnished material for another paper. If they looked at his paper they would see that he did not profess to interpret the law, but only to put forward his views in a tentative way; he wanted all their opinions himself. The discussion had really been more copious and to the point than he expected, seeing that it was rather an intricate subject; and considering that they had only had the paper

before them for a few minutes, he was surprised that it should be understood so quickly. He had handed the paper to a friend of his a few days previously to read; and he said it was so abstruse that he could not understand it, and that was why he had proposed to the President that he should make a few remarks in explanation of it. First, in reply to Mr. Bower, that gentleman represented a Company, and if his Special Act incorporated the Act of 1847, and there was no exception of any of the clauses of that Act, then he was entitled to raise a reserve fund; but if there was a special clause prohibiting this, of course, their Solicitor was right. He should want to see the Act before he could give any opinion as a layman. But he should think it was a most outrageous thing if they were not allowed, as a Company, to raise a reserve fund; for it must be remembered that such a fund was indispensable to a company. A company had no sinking fund as a corporation had; neither had they a depreciation fund. But, as a matter of fact, the reserve fund of a gas or water company served in the place of both these funds. They did not need either so long as they had a reserve fund, because, if the revenue for the year had been such that the balance of profit was reduced below what was necessary to pay the full dividend upon the capital, then they could apply to the reserve fund, so that there was no necessity for a depreciation fund at all. He should strongly suspect that Mr. Bower was mistaken when he said his Company had no power to raise a reserve fund. It might be called by some other name; but they had the power to raise a reserve fund of some kind. As to the investing of the reserve fund, it might be invested in Government or other securities. If it was invested in the works, surely that was a security. Therefore, still speaking as a layman, he did not see there was anything illegal in investing it in the works, though, for the sake of handiness, it would be far better to invest it in Government or other securities outside the works. In his paper, he had given the arguments *pro* and *con*, and he had come to the conclusion that it was desirable the High Court should settle it as it ought to be settled. He quite agreed with Mr. Porter that there was no necessity for a reserve fund beyond 10 per cent. on the paid-up capital. If they looked at it as gas managers, they would find that it struck at the root of their own reputation to have more. Mr. Kendrick said that his Company were entitled to have £25,000; but what was the use of it? After they had paid maximum dividends, and all the dividends for the past years, if they were a statutory company, not under

a sliding-scale, when they went to arbitration, all the money went to the local authority purchasing it; and it was of no use to the company at all. There was no necessity to accumulate a reserve fund beyond 10 per cent. of the paid-up capital; and very few companies would feel any objection to this. Directors, he knew, were often grasping; but the gas manager should be opposed to it. In the case of a statutory company, they took the reserve fund themselves, as also if it was a company working under the sliding-scale—it was their own money; they had accumulated it out of profits to which they were entitled. But when it was not a statutory company with a maximum dividend, then it went over. A sliding-scale company had to accumulate their reserve out of profits which they were entitled to divide; but a company having a maximum dividend, and having paid their full dividends, lost their reserve when taken over. Mr. Wilkinson considered the amount set aside ought to extend over the loan capital as well; but he (Mr. Newbigging) was not sure of this, for, as he had said before, he thought it was quite enough to get 10 per cent. on the paid-up capital. Companies under the Acts of 1862 and 1867 were non-statutory, and could accumulate any reserve they liked, and pay what dividends they chose. Mr. Carr said a corporation were not permitted to have a reserve fund; but he forgot they were allowed to have a sinking fund, which wiped out the capital at the end of thirty years. Some corporations were not restrained from having a depreciation fund. If they had a depreciation fund, there was no necessity for a reserve fund. A depreciation fund built up the works in the course of its life; and a sinking fund actually bought the works. They acquired the works at the end of a certain term free. Corporations and local authorities generally had the power of having both. But he thought a sinking fund was quite sufficient; and there was no necessity for the accumulation of any reserve in the case of a corporation. As to the suspense account, it was understood that no part was to be charged against capital. There was no suspense account belonging to capital. If they suddenly had a sum of money to charge against revenue, then, although there was nothing in the Act giving them power to have a suspense account, yet it was a very convenient method of distributing a heavy expenditure over three or four years.

Mr. RITSON asked if a suspense account could be formed without any provision being made for it in the Act.

Mr. NEWBIGGING said he had done it often, and knew many who did it; it was a very convenient thing to do. He did not

say it was absolutely necessary to do it; because, if the reserve fund was full, and an unexpected expenditure came upon them, it could be met out of the fund. If the Gas-Works Clauses Act, 1847, ever came to be again revised, there would be some provision for a suspense account; but he thought no company were in danger of being called over the coals, if they had a suspense account. A local authority would have more power than a gas company to do it. He thought he agreed with the President's remarks that the nominal capital really meant the paid-up capital, and also that there was no necessity for a reserve fund on anything except the nominal capital. Gas managers should not forget that it was not to their interest to advocate the setting aside of a big reserve fund. There was no necessity for it. It was only a necessity from a director's point of view. The best advice he could give was to go for a reduction in the price of gas after filling up the reserve fund.

Mr. ARTHUR GRAHAM (Mansfield) read the following paper :—

LAYING GAS AND WATER MAINS IN PUBLIC AND PRIVATE STREETS.

The subject I have the pleasure of introducing to you is one which must be of great interest and importance to us all. I do not think there is any other branch of our business where there are so many different ways as in dealing with this subject.

There are many places that cannot see their way to lay gas and water mains unless they have a guaranteed 10 per cent. return before they consider the matter. Now I contend that when we can borrow money at 3 or 3¼ per cent., gas and water undertakings ought to be only too pleased to lay on the connections, because they are certain to increase their output before long—especially since slot meters have been adopted—without any guarantee whatever. There are many cases to-day where people would be only too pleased to be consumers if gas was laid into their streets and houses free of charge, and without the trouble of signing petitions or any guarantee.

Whenever we have an application for laying gas, either up a public or a private street, the first question we ask ourselves is: How many consumers are we going to get, and what will be the return on the cost? In many cases, when the matter comes before our respective Committees or Directors, the same question is asked; and unless we can show or guarantee them 10 per cent. returns, the application falls through, or must be adjourned, or some other method is to be adopted. For private streets, the

owners will be asked to pay a quarter or half the cost, and guarantee a minimum payment of something like £3 per year for five years, or some similar arrangement, on a total cost of about £50; or he must draw up a petition and get all would-be consumers to sign it, and then perhaps they cannot see their way to do it at once.

I quite agree that all cases must be considered on their merits; and we shall find different conditions under many circumstances. But my contentions are that, when we have a street with houses built on one or both sides, it is out of reason to require 10 per cent., or any guarantee, before the work can be put in hand. If we want to increase our business, we cannot do it without extending our mains; and if the cost can only just be covered, it ought to be done. I find that one will soon get consumers to pay 10 per cent. three times over without placing any obstacle in the way whatever. With our slot meters we are giving 25 cubic feet for 1d., with the use of a griller, and laying gas into houses free of charge; and during the past two years we have fixed 460 slot meters. We are now fixing a street-lamp in yards for every ten houses; and in nearly every case, we have all the houses as slot consumers.

Some eighteen months ago I prevailed on our builders to put fittings into houses when building, as I could see before long, when tenants were inquiring after houses, the question would be asked: "Is gas laid on?" They nearly all agreed; and I am pleased to say that the question has already been asked several times. Now in these streets, when we find the pipes have been fixed in the houses, we are only too pleased to lay on the supply without delay—either public or private; and have found in nearly every instance that each house has become a consumer. If this course had not been adopted, there is not the slightest doubt that it might have been years before the gas was laid on.

I attribute our rapid development to taking this course, for five years ago we were only making 66 millions, and the present year we shall make 95 millions, or about 44 per cent. increase; and the greater part of this has taken place during the past 2½ years. We have also reduced the price of gas 9d. per 1000 cubic feet. Then I say, Why should we hesitate about running a little risk for a short time by laying gas-mains in our streets, when there are plenty of houses that would take slot meters, but cannot get them because no one comes forward to promote a petition or guarantee the usual 10 per cent.?

In a case where they are laying out new streets—there being no houses, and gas and water mains are being laid—I consider

it is in order that 10 per cent. return should be guaranteed, because one does not know when houses are going to be built. Twelve months ago we laid both gas and water mains in three new streets; and the arrangement we came to was to allow the owner to do his own excavating, the Corporation to lay the necessary mains, and the owner to pay 10 per cent. on the mains until there was sufficient property erected to pay the necessary 10 per cent. But this, in my opinion, is an entirely different thing, as there are only three houses being erected at present.

In conclusion, I maintain that a great many consumers may be obtained if only gas undertakings would run a little risk, lay mains and fix services, and give meters free where there are houses. Consumers are certain to come, now that so many facilities are given—at least, that has been my experience. My reason for introducing the subject was to hear what my brother managers were doing elsewhere, and to see if any new ideas or improvements can be made in the way of increasing our business.

Discussion.

The PRESIDENT thought the members would generally agree with Mr. Graham's view. The question was whether it was worth while to adopt a pushing and speculative policy rather than adhere to the old "stick in the mud" policy.

Mr. H. TOWNSEND (Wakefield) said that when he first went to his present works they charged for putting in service-pipes on all private property; but the accounts gave a great deal of trouble, and they seemed to set the customers' backs up. So that, as it did not amount to more than £100 per annum in the aggregate, he advised his Directors to abolish it, and to go in for laying mains, and fixing meters and stoves free of cost to the consumer. The result was that they had got every house which had been built since as a customer, whereas previously they had only one in four. He thought this information might be useful to other managers, and would entirely support Mr. Graham.

Mr. H. KENDRICK (Stretford) said, with regard to suburban property, there was sometimes a limit to the length of a service-pipe. One works with which he had been connected had a limit of 30 feet from the nearest footpath. It was originally from the nearest main, which would mean, in one particular road that he had in his mind, that all the consumers would pay half the cost of the service-pipe. So far as fixing meters was concerned, he had seen three works which worked on three different systems. The first was a corporation works, where they fixed them by fitters under their own control; but they charged a lump sum

of 5s. all round. The second works fixed them by their own fitters, and did not charge anything. The third works did not do any fixing at all, but left the consumer to get it done by a local plumber. He should say that it was far better for companies—and he had urged this upon his own people, though he was sorry to say with very poor success so far—to keep all this work in their own hands, and not let the local plumber have anything to do with it. The meters were their own property; and the local plumber did not understand the fixing of them. If it were not for the trouble they gave rise to, the mistakes made by the local plumber would be extremely amusing. Although no charge was made to customers in the Manchester district for fixing cookers, it was a mistake to say that they were fixed free of charge, because an increased rental was charged. The extra amount that was charged did not press very hard on the consumer, and did no more than repay the interest to the corporation or gas company. For instance, they had a contract price of 25s. with the plumbers in the neighbourhood for the fixing of any gas cooker; and they got 2s. a year from the consumer. So that they did not make a large amount on it, considering that they had to cart the cooker out, and bring it back again when it was done away with, at their own expense. Another point that had been brought before District Associations on previous occasions was how far the officials should have control of the gas. Should it end with the meter or the burner? Personally, he had rather strong feelings upon this point. He thought gas companies' control should extend to the burner—even going to the extent of distributing new burners free, though he was afraid many consumers would rather look askance at them if they suggested it, for they would want a guarantee that their gas bills would be lessened and not increased. It behoved everyone who had any idea of taking up this work to see how it would affect him personally. Reverting to the first point raised by Mr. Graham, as to what the company should do with regard to laying mains in roads, they would have to take into consideration whether it was in a suburban or an urban road. His district happened to be entirely suburban; and his Directors would have to take up the position which Mr. Graham appreciated, of trying to get from the landlord some payment towards the laying of mains. In most cases the roads in his district came under the second category, of being slowly built upon. He thought this was a point that needed more discussion, and should be more thought about than it had been in the past.

Mr. C. Wood (Bradford) quite agreed with Mr. Graham that

they should do everything they could to encourage the consumption of gas, and ought not to insist upon having a 10 per cent. return on the cost of the mains or services in all new districts. Perhaps in Bradford they were fortunately situated in this respect, having a somewhat restricted and well-built-upon area of supply. There were scarcely any householders at all in Bradford who were not consumers of gas. For many years gas-fittings had been put in all new property as a matter of course; and therefore, also quite as a matter of course, they had caused gas to be consumed. They had a rule of charging for an extra length of service over 30 feet on private ground; but this was insisted upon in only a very few instances. They found in the case of suburban houses, where they sometimes had to lay 50 or 60 feet, the return from the gas supplied amply repaid for the extra length. As a rule, they were large houses with long gardens, and there was no difficulty in getting the accounts paid. They had also in Bradford a very good system of collecting the accounts. But they were a little backward in one respect—viz., that very few of the meters belonged to the Corporation, the bulk of them being the property of the owners of the houses. The owners were responsible to the Corporation for the gas supplied in the case of cottages rented under £10 a year. They paid in a lump sum, and collected it weekly from the tenants. The property owner got an additional discount for this, which he thought repaid him for his trouble. In Bradford, it had been the practice for many years in all the new streets (and many old ones) to lay the mains under the footpaths on both sides. This reduced the leakage very much. They had a great deal of granite paving with concrete underneath; so that the mains in the middle of the roads were most difficult to get at in case of leakage. He had known a case where the leakage was more than 100 yards from the place where the gas was first detected. It was also necessary to have some recognized rule as to where mains should be laid, especially in towns where there were gas and water mains, telephone pipes, post office pipes, and electric cables in pipes. Only the previous week a curious thing had happened. They had from their works a 5-inch ammoniacal liquor main which went to their chemical works; and the men from the Water Department had tapped the main, and they might have put the connection to the house if they had not at the opportune moment started sending some liquor through the main at 40 lbs. pressure. It was certainly necessary that each department should know where the mains of every other department were situated.

Mr. TOWNSEND wished to add to his previous remarks that, for the protection of the Company, they publicly announced that they laid services free within 25 yards of the main. This gave the Company power to escape any difficulties of the nature of those which had been referred to by Mr. Kendrick. As a matter of fact, they found that it was very seldom the length of a service exceeded 25 yards.

The PRESIDENT said the question raised by Mr. Graham could not fail to be of interest to every manager, because they would all at one time or other have to lay mains. The subject suggested itself differently to different minds. His Company were about to promote an Act of Parliament; and the difficulty they had had with regard to private streets had led them to insert a clause authorizing them to lay mains in private streets as they did in public streets. It might sometimes be a question whether they could get the requisite permission to put down the pipes. Mr. Graham's people seemed to have the idea that property owners should pay or guarantee a certain return on the outlay; but he (the President) thought this was becoming more and more out of date every day.

Mr. GRAHAM, in reply to Mr. Kendrick, as to drawing the line for laying a service-pipe free at 30 feet, said all he could remark was that if there was any doubt whether an intending customer would have the gas if he had to pay for laying the service-pipe, he should let him have it free. The cost of 30 feet of pipe was only trifling. As to fixing meters, one company he was connected with charged 2s. 6d. for fixing and 2s. 6d. for changing meters. He thought this so absurd that he changed it. With regard to cookers, they took 25 per cent. off the cost price, which left them 5 per cent. on their purchase. He did not think they could do much in the way of giving the consumers satisfaction with regard to gas-burners. He quite agreed with Mr. Wood that it was right to lay the mains on both sides of the road; but this was only in the case of wide ones—it would not do in ordinary streets. He thought it would have a tendency to reduce the leakage, and, of course, they would be able to work at a less pressure. One company he was connected with would not fix meters of more than 5-light size unless they were purchased; but he thought this was altered now that the corporation had bought them up.

The PRESIDENT said he was afraid that Mr. Graham's last sentence might create a wrong impression. It was not always necessary for a corporation to buy up a company in order to bring about an altered policy.

Mr. G. W. LUPTON (Otley) read a paper entitled—

PROFIT-SHARING, OR PAYMENT BY RESULTS.

In introducing this subject for discussion, I hope more to gain information than to give it. It is a subject in which I feel very deeply interested, and one that I hope will promote a very wide expression of opinion among the members of the Institution.

To commence with the manager. I think every manager should have a pecuniary interest in the prosperity of his works—over and above his salary. I mean to say, let him have a suitable salary, and in addition a small percentage of the gross profits. In the "Gas World" dated Oct. 14 last, I noticed a paragraph in regard to the salary of a gas manager, in which it was suggested to pay him a "percentage of all profits in excess of a fixed minimum." This was described as absurd; and I quite agree with that verdict. But had the suggestion been to pay the manager a much smaller percentage of the gross profits, then I think the idea is quite feasible. If a manager only receives a percentage of the profits over and above a fixed minimum, in case of a coal strike, or other unforeseen circumstance, his percentage would very probably be *nil;* and this from no fault of his own. But if he still receives a percentage of the gross profits, then I consider he may very well take his chance along with the shareholders or ratepayers as the case may be.

In the same paragraph in the "Gas World," I noticed also the following sentence: "What is to become of the manager's salary when the price of gas is reduced." Well, here again I say let him take his chance as before. In a prospering concern, as a rule, a reduction in the price of gas does not mean decreased profits, or, at any rate, not for long.

Two years ago, at my own special request, my Directors agreed to pay me a small percentage of the gross profits, instead of an advance of salary. I certainly have no cause for regret, although the price of gas has since been reduced; and considering that the Chairman of the meeting—when presenting me with a cheque for my share of the profits—remarked that he "hoped it would be twice as much next time," I conclude that my Directors were satisfied. In my own case, I am perfectly satisfied to feel more like a small partner in my Company than simply a paid servant. I know, and my Directors know, that what benefits me is also a benefit to the Company.

With regard to capital and revenue expenditure, we keep to the strict letter of the law—always maintaining the works in quite sound condition at the expense of the revenue, as may be

seen from our balance-sheets, and charging capital with any amount properly belonging to capital.

With regard to the workmen, we cannot very well pay them a percentage of the profits; but we might, I think, give them a bonus for certain results. How this is to be arranged is not so easy to decide; but in the case of stokers I would pay them a fixed sum, per month (say), for certain results based upon the make of gas per ton of coal carbonized, or make of gas per man, or both. If we can only get the men to believe that their employers are anxious that they shall receive fair remuneration for work done, then we shall have a better feeling between masters and men. I would pay the men a certain amount extra for results equal to, or above, a certain standard. In my own case, I have just started the system by agreeing to pay a certain sum per month to each man on condition that the make of gas is not less than 10,000 cubic feet per ton. In many works, perhaps, the standard might be higher; but in my case we use ordinary gas nuts and unscreened coal, which should yield 10,000 cubic feet of gas per ton. I do not aim at more, as we use no cannel or other enricher; and our consumers are accustomed to gas of good quality. Our standard quality is 15 candles; and we supply 16½-candle gas. Two or three years back, when we could buy best screened gas coals for much less than we now pay for nuts and unscreened coal, and in addition always received a nice amount of coal in overweight, we could easily make 10,300 to 10,500 cubic feet per ton; but with the present net weights and lower quality of coal, I place my standard at 10,000 cubic feet per ton. There is no doubt a lot of gas can be saved by the men paying attention to small details; and on announcing to them that I intended to give them a bonus for results up to a certain standard, I explained—not for the first time—how it could be done. Neglect to use the auger is a source of waste of gas; and some of the temporary hands will do this if no one is about to watch them. Also gas blowing at the lids, perhaps only slightly, but it all tells. Also, when charging, some men scatter a little coal in front of the retorts; and this is lost for gas-making purposes. Small, and even large cracks in the retorts, are sometimes left unpointed. The permanent hands—so long as they had no special interest in doing otherwise—let new hands find out for themselves the best way to do their work. Since the bonus system was started, all these faults have been greatly minimized; and I hink, in my own case, the idea will be a success.

The amount earned by the men in bonus will not be paid to

them in cash, but credited to them, and allowed to remain at interest in the hands of the Company. In the case of the temporary hands, when they are discharged at the end of the winter the amount of bonus will be handed to them or allowed to remain in the hands of the Company at their option; and in the case of the permanent hands I propose that they also shall allow their bonus to accumulate at interest until some special expense may necessitate its withdrawal. In this way, I propose to encourage the men to put by for a rainy day. The idea may be beset with difficulties; but what are difficulties except to be overcome? If we can encourage thrift in our workmen, and good feeling between them and their employers, the end attained is worth a good deal of trouble in the attaining.

Some may argue that the men might use the exhauster as a means of increasing the make; but that objection may be overcome by fixing a register on the exhauster inlet.

It has always been my custom to take stock of coal, coke, tar, and liquor at the end of each month, and so ascertain the make of gas, tar, and liquor, and sales of coke per ton of coal carbonized; and that is why I suggest a monthly bonus. But, of course, the bonus might be quarterly, or any way to suit individual circumstances.

Since writing the foregoing, I have received, through the courtesy of Mr. Livesey, a copy of his paper on profit-sharing, as delivered by him at the Labour Association Conference at Newcastle-on-Tyne in October last, and which includes every detail of his scheme. It is the first time I have had the pleasure of learning the full details of Mr. Livesey's system; and I am surprised that such an excellent profit-sharing scheme is not more widely adopted. I feel my poor little idea to be very small in comparison; but everything must have a beginning, and I intend—with the permission and co-operation of my Directors—to give profit-sharing a fair trial. I have confidence in attaining ultimate success; and I am sure if everyone employed on a gas-works could share to some extent in the profits, it would be to the benefit of the consumers as well as of the shareholders and themselves.

Discussion.

Mr. J. H. Brearley (Longwood) said Mr. Lupton had been very happy in his choice of a subject, which was one that required careful consideration. There might be a temptation with some gas managers to starve their works in order to make

a profit, and thereby get an increased commission, and then go to some other works; but they knew that gas managers were above this. Profit-sharing could not be applied to corporation works, which placed a large amount of expenditure on new meters and new streets to revenue, and would never be able to get at the profit, so that the manager could not estimate his commission. A system of payment based on the increased quantity of gas sold was perhaps a better plan. There was then a direct inducement to the manager to push the consumption of gas in the way of cooking-stoves, &c.; and this would ultimately tell upon his surplus profits. In his own case, they had practically a surplus of 40 or 50 per cent. of power all round, which only cost them a little extra in coal and labour; and for every million cubic feet of gas they could increase their sale, they would obtain £100 profit. Therefore, in his case, it was of much more importance that the manager should push the sale of gas than that he should aim at a large profit by merely getting the stokers interested in carbonizing. If the stokers were put under proper control, there would be no such thing as cracked retorts requiring pointing. In works of medium or large size, if there was a proper foreman stoker he would look after this.

Mr. W. Doig Gibb (Newcastle-on-Tyne) said as Mr. Lupton had referred to Mr. Livesey's address at Newcastle, which he (Mr. Gibb) had heard, he would like to make a few remarks. Mr. Livesey came to Newcastle to give his address in connection with a Free Labour Association that was formed to promote co-operation between the workman and his employer. Mr. Livesey was accompanied by three or four of his workmen, who gave their experiences; and certainly from what they said one formed a very high opinion of the benefit of such a scheme in gas-works. Unfortunately, the effect of Mr. Livesey's address was rather marred at the end by two or three people who took him to task for, as they suggested, having floated his profit-sharing scheme not so much for the purpose of benefiting his workmen as for fighting a labour organization. But he (Mr. Gibb) thought the feeling of the meeting was properly expressed when the Chairman said, in his closing remarks, that a profit-sharing system was not necessarily antagonistic to a Labour Union. If such a Union was conducted on proper lines, and confined itself to its proper duties, there was no reason why profit-sharing and Labour Unions should not go hand-in-hand. But when a Labour Union exceeded its legitimate scope, and put undue pressure on the employers, it was better to run a gas-works with free labour and profit-sharing than without. He agreed with Mr. Lupton

entirely that some sort of bonus sharing was a good thing. Mr. Lupton said that the men should get paid their bonus, and be allowed to have an interest in the company. He often thought, as against strikes, that it might be possible to arrange to pay the workmen in monthly batches—one-twelfth to be in January, one-twelfth in February, and so on; so that at no period would the company have less than one-twelfth of their total workmen with some bonus in the company's hands, which would be sacrificed if they came out on strike. Such a system might result in getting the workmen to perform their duties honourably.

Mr. C. Wood (Bradford) was much interested in Mr. Lupton's suggestions with regard to the bonus scheme, and wished him every success in his efforts. He tried a similar scheme in Bradford seven or eight years ago; but he was sorry to say it was a complete failure. They offered the men a certain sum, payable monthly, based upon the production per mouthpiece at the various works—taking a low figure as the minimum, and paying them a certain amount for all increases above it. As it worked out, the men would have been considerable gainers, and so probably would the Corporation have been; but the men objected to it very strongly. The men were advised by the Union officials that there was something hidden behind it—that it was some means of getting more work out of them; and they actually threatened to strike if the bonus scheme was not withdrawn. It was, however, never withdrawn; the men were merely told that if they did not like it, they need not have the money. If the men had accepted it, many of them would have been receiving 4s. a week more than they were now getting; but they refused to have it.

Mr. J. Wilkinson (Drighlington) congratulated Mr. Lupton on his paper, with which he agreed; but he thought there were many difficulties in the way of such a scheme as he referred to. Different circumstances occurred in different works; and the great puzzle would be to know the proportion or percentage which should be paid to the manager or the workmen. He did not think it fair that a workman should lose all his bonus through some act of insubordination. He might have done his duty during twelve months of the year, and have become entitled to his bonus; but he should not, through some slip, or the manager losing his temper—as managers did occasionally—forfeit the bonus he had properly earned. In the case suggested by Mr. Brearley, of a manager starving his works and then going away, the man who followed would have his salary made a fixture. With regard to what Mr. Wood said about the Bradford men

being entitled to 4s. a week more if they had accepted the Corporation's terms, he did not think it would be long before they put in a claim for it, if it got to their ears.

The PRESIDENT said this was a very interesting subject. He agreed with Mr. Lupton that, if anything could be devised which would interest the workmen in the success of the undertaking more than they were at present, it would be beneficial to everyone concerned. As to their own remuneration, some of them might have cause to complain; but a great many of them were in the hands of a generous class of men so far as committees and boards of directors were concerned, and perhaps it was preferable to have their services recognized by a little surprise than to have their remuneration increased by a commission which sometimes might be said not to have been fairly earned.

Mr. LUPTON, in reply, said his object in preparing the paper was more to elicit the opinions of others than to lay down the law on the matter. Mr. Brearley talked about the possibility of a manager starving the works. That was all very well; but he did not suppose that a man would be started on the system right away. He would have to prove his worth first. In his own case, he had been six years with his Company before he went on the system. It paid him very well; and his Directors were satisfied, and had sufficient faith in him to know that he would not starve the works. Further than this, unless a man happened to know that he would get another situation directly, it would not pay him to starve the works, because he would only too soon reap the fruit of his misdeeds. With regard to paying on an increased sale of gas—if they increased the sale of gas they increased the profits, so that it all came back to the same thing. His own works were too small to think of having foremen as had been suggested. He wished to thank Mr. Gibb for his remarks, which had afforded him much information. He could quite understand that in a large place like Bradford the profit-sharing system would be more awkward to introduce; but in a small place like his own, he had his eye on all his men. Since he had been at Otley, the men had never got an advance in wages unless they had secured increased results; and they had always been told that it would be so. In his own case, it seemed to have established good-feeling between himself and the men—at any rate, they had always been perfectly satisfied. Mr. Wilkinson said there would be difficulties. He expected difficulties; but they must try to get over them as time went on. He agreed that a man should not be made to forfeit what he had earned. If a man left the works himself, he took himself and his bonus away

at the same time. In conclusion, he thanked the members for their remarks on the paper, which had greatly interested him.

Vote of Thanks.

Mr. H. Hawkins moved a vote of thanks to the readers of the papers, which, he said, had been very interesting, and for which the members were greatly indebted.

Mr. Brearley seconded the motion, which was carried unanimously.

Mr. Graham and Mr. Lupton briefly returned thanks; and the proceedings closed.

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